

DATE: November 19, 1998

SUBJECT: Comments on Midwest Metallics Remediation

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Pesticides & Toxics Branch

TO: John Gaitskill
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The following are requested comments concerning the Remedial Investigation (RI) Work Plan submitted by Midwest Metallics' consultants, W.Z. Baumgartner & Associates, Inc.

- * The RI Work Plan, Appendix B, shows a single composite sample collected at the recirculation basin in March of 1994 that was analyzed for PCBs. Since this was a single sample conducted over four years ago, further sampling of the basin should include PCBs as a parameter.
- * Background sampling for metals has been proposed as an addition to the RI Work Plan. Due to uncontrolled environment for storage of fluff at the site, a true background level for metals may be difficult to establish. What would help to minimize the problem would be to identify areas that historically have not been exposed to fluff storage, fluff processing or movement of fluff and use these areas for background sampling.
- * Although discussed at the October 21, 1998 meeting with Midwest Metallics' consultants, W.Z. Baumgartner & Associates, Inc., the Work Plan needs to include PCB analysis for the pile.
- * The October 21, 1998 meeting included addressing the issue of sampling the base and central portion of the pile. Specifically, the EPA felt that RI Work Plan proposal of only sampling the first 20 ft of the pile, using grid sampling, did not address the base portion. It was therefore proposed that the base area would be divided into quadrants and sampled after removal of the top layer. A large percentage of the pile volume is included in the base portion and should be the oldest material in the pile. In general, the scrap industry has made less effort to remove lead and PCB containing materials further back in time. Therefore, the number of sampling events for the oldest material (base portion) should at least be equivalent, on a per volume basis, to that of the top portion of the pile.
- * Surface material, found on or in the soil surrounding the pile has not been subjected to the high temperatures and combustion that is found within the pile. Since these conditions could destroy or volatilize PCBs, samples taken from the pile may have different PCB concentrations from similar material found in the pile. Core sampling, compositing material in the first two feet of soil, has been proposed. However, this would dilute contamination found at the surface. The RI Work Plan needs to include surface sampling for PCBs in the areas surrounding the pile.

**DRAFT REMEDIAL INVESTIGATION
WORKPLAN**

**MIDWEST METALLICS, L.P.
SUMMIT, ILLINOIS**

SEPTEMBER, 1998

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**DRAFT REMEDIAL INVESTIGATION
WORKPLAN**

**MIDWEST METALLICS, L.P.
SUMMIT, ILLINOIS**

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Respondents have secured the services of W.Z. Baumgartner & Associates, Inc., Environmental Consultants, in preparation and implementation of the Remedial Investigation Workplan. W.Z. Baumgartner & Associates, Inc. has extensive experience in characterization of scrap metal shredder residue and environmental assessment of scrap metal recycling facilities. Respondents are responsible for implementation of the Remedial Investigation and will coordinate all phases of the work with its contractors and representatives of Region 5 and IEPA as required by the Order.

1.0 INTRODUCTION

The Respondents previously operated a scrap metal shredding facility at 7955 West 59th Street, Summit, Illinois. Prior to operation by the Respondents, this facility was operated by others as Pielet Bros. Auto Processing. A scrap metal shredder is present onsite and is utilized for the processing of scrap metal articles, such as automobile hulks and light iron. The shredding process facilitates separation of ferrous and non-ferrous metals from non-metallic materials contained in the infeed material.

The scrap metal shredder consists of a large drum, or rotor, to which a number of metal hammers are attached. Each hammer is bell shaped in profile and is attached to the rotor by a pin. The hammers are free to swing in the same plane as the rotor rotates and are staggered across the rotor to enhance shredding performance. The rotor is typically driven by electric or internal combustion engines at a speed of 400 to 700 revolutions per minute. As infeed material is introduced to the mill, the hammers deliver a series of tearing or shredding blows to the infeed material. Material remains within the mill until it is sufficiently reduced in size to pass through a grate in the mill and continue by conveyor to downstream separation processes. These downstream processes include magnetic separation of ferrous metals from non-ferrous metals as well as separation of metallic materials from non-metallic materials, commonly referred to as shredder residue.

Shredder residue consists predominantly of non-metallic solid material, including plastic, glass, rubber, foam rubber, soil, carpet and fabric. It is an unconsolidated, heterogeneous solid, medium to dark brown in color and typically exhibiting a slight, musty

odor. Individual objects are generally identifiable in the material. These may include seat cover fabric, headliner, carpet, gasket material, dashboard components and automotive trim. Shredder residue typically accounts for approximately 20% of the infeed material mass, or approximately 500 to 600 pounds per automobile.

HISTORICAL PERSPECTIVE

PERIOD OF GENERATION/STOCKPILING AND REGULATORY HISTORY

(To be added.)

2.0 PURPOSE

The purpose of this remedial investigation is to characterize the nature and extent of environmental contamination that may have resulted from the storage of automobile shredder residue at the Midwest Metalics L.P. site in Summit, Illinois. This workplan proposes a scope of work sufficient to characterize contamination of the pile by hazardous substance and to evaluate the impact of these contaminants on the soil and groundwater on-site.

Following review and approval of the Remedial Investigation Workplan by U.S. EPA staff, the Respondents will implement the procedures described in the Remedial Investigation Workplan in a timely manner. The Respondents will likewise submit the required progress reports to Region 5. As recommended by its consultants and/or contractors, where appropriate, the Respondents will revise the Remedial Investigation Workplan to address site-specific conditions and findings.

EXECUTIVE SUMMARY

The United States Environmental Protection Agency, Region 5 has issued an Order, pursuant to Section 3013 of the Resource Conservation and Recovery Act, 42 U.S.C 6934, requiring investigation of the Midwest Metalics L.P. site in Summit, Illinois. Midwest Metalics L.P. was previously engaged in scrap metal recycling and operated a metal shredding facility at 7955 West 59th Street in the Village of Summit, Illinois. Prior owners of the facility stockpiled shredder residue on the subject site for a number of years. Current estimates of stockpile volume range from 150,000 to 180,000 cubic yards. Limited testing of stockpiled shredder residue by representatives of Region 5 and the Illinois Environmental Protection Agency (IEPA) suggests that some portion of the material may exhibit a hazardous characteristic for leachable lead. Concern over material characteristics, storage configuration and management practices have resulted in issuance of the Order. Preparation and implementation of the Remedial Investigation Workplan is a requirement of the Order.

Midwest Metalics L.P., a limited partnership, and S.D. Metals, Inc., an Illinois corporation and general partner of Midwest Metalics, propose to comply with the requirements of the Order. Respondents will initiate the Remedial Investigation, as described in Section V of the Order, so as to characterize the stockpiled material, identify and characterize potential contaminant migration pathways, define the horizontal and vertical extent of contamination resulting from the stockpile and identify actual and/or potential receptors. Implementation of the Remedial Investigation Workplan will provide site-specific data of such quality and scope so as to substantiate or refute the Findings of Fact as contained in the Order and facilitate future decision-making by U.S. EPA.

3.0 SCOPE

The Respondents will direct the collection of information and data sufficient to satisfy the purpose as stated in Section 2.0. More specifically, consultants and contractors to the Respondents will address the following issues:

Environmental Setting

Environmental setting will be defined through evaluation of site-specific hydrogeology, soils and sediment which may have been impacted by shredder residue stockpiled at the site. Soil borings and groundwater monitoring wells will be positioned outside the footprint of the residue stockpile for a number of reasons. It is likely that the long-term stockpiling of shredder residue has resulted in considerable static loading of soils immediately beneath the stockpile, which may influence soil porosity, permeability, the presence and/or depth to groundwater and other physical conditions beneath the stockpile. Conventional drilling and sampling technologies are not suited to boring or probing through shredder residue and, due to the sheer volume of material involved, relocation of material to facilitate a soil boring and/or groundwater monitoring well within the footprint of the pile is not practical. The Engineers are confident that the location and distribution of soil borings and groundwater monitoring wells is adequate to characterize the nature and extent of any contaminant migration from the stockpile and satisfy the requirements of the Order.

While available information regarding offsite wells and surface water intakes may be solicited from the IEPA Bureau of Water Supply, Illinois State Water Survey and other resources, offsite surface waters are not subject to characterization during this remedial

investigation. This decision was made upon review of previously generated data characterizing sediment within the former recirculation basin and site drainage patterns. Contaminant migration to surface waters would most likely be due to solids contained in storm water runoff. Storm water from much of the shredder residue stockpile and surrounding area drains to this basin, and the absence of chemical constituents of concern in basin sediments would suggest that any contaminant migration due to erosion by storm water is minimal and that this potential migration pathway is interrupted by the recirculation basin.

Source Characterization

Section 5.0 presents the sampling plan for characterization of the shredder residue stockpile. This random, three-dimensional sampling approach is consistent with guidance provided in EPA document SW-846 and has been used previously, to the satisfaction of Region 5 staff, in characterization of shredder residue stockpiled at the H&H Enterprises site in Gary, Indiana. Sample collection, preservation, processing and analysis as prescribed in this Workplan are consistent with the previously approved submittal. Additional analytical determinations, both chemical and physical, have been included to satisfy the scope of this investigation.

Contamination Characterization

Soil, sediment and groundwater (if encountered) samples shall be collected and analyzed to determine the magnitude and extent of contaminant migration from the shredder residue stockpile. Soil and sediment samples will be collected from locations and at depths most likely impacted should any contaminant migration have occurred. Groundwater samples will be collected both upgradient and downgradient of the residue stockpile, and the spacing

and orientation of these wells will be such that seasonal or other changes in groundwater flow direction and rate may be determined. The quantity and quality of data developed during this phase of the remedial investigation will be useful in determining which, if any, of the potential receptors identified in Section 7.0 of the Workplan are at risk.

Potential Receptor Identification

A variety of resources will be used in an effort to identify potential receptors. This information will be secured for populations and ecosystems likely to be impacted should significant contaminant migration be discovered during the remedial investigation. No specific identification radius has been provided by Region 5. It is proposed to limit groundwater well documentation to within one-half mile of the center of the subject site, due to the extent of industrial development in the surrounding area and absence of data suggesting widespread utilization of shallow groundwater resources in the area immediately surrounding the subject site. Should additional information be discovered which suggests shallow groundwater utilization is more prevalent than previously known or believed, then this radius may be expanded at the recommendation of the Engineers.

The Scope of Work, more specifically described in Sections 4.0 and 7.0 of this Workplan, proposed by Midwest Metallica L.P. and S. D. Metals, Inc. is based upon their knowledge and experience at the subject site and the expertise of W. Z. Baumgartner & Associates, Inc., Environmental Consultants. W.Z. Baumgartner & Associates, Inc. is a multi-disciplined consulting engineering firm with extensive experience in the scrap metal recycling industry. The Engineers are widely recognized as environmental professionals of considerable knowledge and expertise as it relates to scrap metal recycling facilities in general.

and shredder residue waste streams in particular. The Engineers have provided waste characterization, environmental assessment and/or project management services to many of the scrap metal shredding facilities within the U.S. and Canada. W. Z. Baumgartner & Associates, Inc. provided engineering services to Midwest Metallics L.P. during characterization of shredder residue stockpiled at the H&H Enterprises site in Gary, Indiana. Documentation of work experience involving environmental site assessments, remedial investigations, state Superfund projects and RCRA closures is attached as Appendix A.

The Respondents will direct their consultants and/or contractors to develop the necessary site- and area-specific information. Where deemed necessary, the Respondents will make reasonable attempts to secure access to adjoining properties for the purpose of satisfying the requirements of the Order.

4.0 ENVIRONMENTAL SETTING

4.1 GEOLOGY/HYDROGEOLOGY

4.1.1 REGIONAL GEOLOGY

The surficial geology of the greater western Chicago area is comprised of glacial landforms, glaciolacustrine and glaciofluvial deposits, till, meltwater deposits, and recent alluvium. Till and/or alluvium is from five to two hundred feet thick and is underlain by shale, limestone, and dolomite bedrock.

Along the Des Plaines River, west of the Midwest Metalics Argo site, there is a major unconformity. Glacial sluiceways have cut through much of the till and Pennsylvanian rocks exposing Silurian formations of dolomite. This is a prime area for rock quarrying. The soil is thin near the river and is comprised of some alluvium overlying either till or bedrock.

The exposed or subsurface Silurian formation in the vicinity of the Argo site is called the Racine Formation and is characterized by the Illinois Geological Survey as largely dolomite, slightly to moderately argillaceous with scattered chert nodules. Some areas contain massive to well-bedded pure dolomite. Minor beds of shale may exist at depth within this formation.

The oldest surficial deposits near the Argo site are localized bars of sand and

gravel from the Henry Formation that have in-filled glacial sluiceways. The Henry formation is largely glacial outwash containing sand and gravel with minor and local beds of silt. The outwash deposits have a thin cover of silt. Moving eastward from the Des Plaines River, the soil is derived from floors of glacial lakes flattened by wave erosion overlying glacial till.

Holocene stage alluvium is called the Cahokia Alluvium and is characterized as the deposits in floodplains and channels of modern rivers and streams containing mostly poorly sorted silt and sand with local deposits of sandy gravel.

4.1.2 REGIONAL HYDROGEOLOGY

Regional groundwater moves toward Lake Michigan. However, in areas of heavy pumping, the reverse may be true. The gradient is very small and historically, several deep rock aquifers have been used. Locally, in the Village of Summit, shallow groundwater appears to move towards the Des Plaines River and Chicago Sanitary & Ship Canal. From the Argo site, this direction is to the west and northwest. The enclosed hydrogeology diagram, presented as Figure No. 5, shows groundwater following the topography. During the rainy season(s), some surface water ponding may occur at the northwestern boundary of the site.

Groundwater flow direction is probably due to increasing permeability of sediments close to the river and shipping canal. Glacial lake deposits overlying till have less permeability and greater depth to bedrock. This would prohibit groundwater

from moving eastward from the site.

4.1.3 LOCAL GROUNDWATER USE

Records have been obtained from Illinois Geological Survey records and from the State of Illinois Water Survey Database showing nearby wells and well logs for the last 100 years. Well logs show productive aquifers at approximately 300 feet, 600 to 900 feet, and 1500 to 2000 feet. Production (gallons per minute) greatly increased with depth.

The records obtained by W. Z. Baumgartner and Associates, Inc. verify published regional geology. The most recent well was drilled in 1978. All future groundwater usage has been banned in the Village of Summit. Upon enacting the workplan, W.Z. Baumgartner and Associates, Inc. will attempt to determine if any of the older wells are still in use and if the ordinance banning groundwater usage is being enforced. According to a 1994 database of industrial wells, all nearby wells have been abandoned or sealed except for one well belonging to Liquid Air Corporation.

4.1.4 SITE GEOLOGY AND HYDROGEOLOGY

W.Z. Baumgartner and Associates, Inc. have obtained a subsurface exploration report for the Argo site, which was performed in February 1988. Eldridge Engineering Associates hired the D & G Drilling Company to drill four boreholes to bedrock. Borelog information from the 1988 report is used to show the fill/till

contact, the till/bedrock contact, and water levels on the enclosed geology diagram. Site geology is characterized by man-made fill overlying glacial till which overlies bedrock. Bore logs show higher permeability to the northwest and west. The sand and gravel of outwash and alluvial deposits is more prevalent near the Des Plaines River. Bedrock is assumed (auger refusal) or encountered within 20 feet of the surface. At the northwest corner of the site, dolomite is encountered within 13 feet of the surface.

At the southwest part of the site, in the vicinity of the shredder, fill appears to extend all the way to bedrock. Otherwise the fill layer is generally 2 to 4 feet in depth. Shallow groundwater is encountered within 4 feet of the surface, except to the northwest where it was 8 feet down. This, again, suggests a groundwater gradient towards the northwest and west.

The bedrock dips to the south and southwest. Therefore, shallow groundwater movement is not influenced by bedrock orientation.

4.1.5 MAN MADE INFLUENCES

Soil in the vicinity of the shredder is probably highly compacted from vibration. Compaction, due to long term static loading, would also be a factor affecting soil and groundwater below the stockpile. As bedrock is not very deep, the radius of compaction would not extend nor affect groundwater over 20 feet away from the pile. However, in areas of high compaction, groundwater flow direction may not

be properly determined.

Based upon review of available data, geophysics would not be useful in determining groundwater flow from the property. The soil is too heterogeneous and randomly compacted. Even if the grid interval was reduced in size, the margin of error in geophysics data would not be as great as the margin of error in a groundwater flow model such as MODFLOW. The information generated by a numerical model such as MODFLOW would not accurately represent actual site conditions.

Surficial geology maps, stack maps, local area drill logs, and on-site borings suggest groundwater will be encountered above bedrock. Due to prohibitions on shallow groundwater utilization and depth to bedrock groundwater, no bedrock groundwater wells are believed necessary and no such wells will be constructed.

Monitoring wells placed adjacent to the pile or shredder should yield good chemical data but may not be useful in determining contamination transport off-site, due to soil compaction resulting from static loading by the stockpile and vibration from the shredder. Shallow groundwater monitoring wells will be positioned accordingly, and will be oriented such that upgradient and downgradient conditions may be determined.

Downgradient monitoring wells should be placed at least 50 feet away from the shredder and stockpile.

4.2 SOILS

Site-specific soil conditions will be assessed during this Remedial Investigation. As described in Section 4.1, engineers and/or geologists will be present during installation of soil borings and groundwater monitoring wells (if required) in order to develop information required by the Order. Specifically, samples will be collected in distinct locations and at depths such that 1) the horizontal and vertical extent of contamination resulting from the stockpiled material may be determined, 2) the physical properties of each distinct soil, fill and rock unit may be described and 3) graphical representations of subsurface conditions, both physical and chemical, may be prepared.

Maps and cross-sections representing the extent of residual contamination, distinct stratigraphic units and depth to groundwater will be prepared. Where necessary, subsurface conditions may be interpolated in order to develop the required graphical exhibits.

Respondents propose installation of six (6) soil borings in the immediate vicinity of the stockpile. Each boring will be positioned at pile characterization grid intersections, as shown on Figure 2, to facilitate the location of each using surveying equipment. Each soil boring will be completed to groundwater, refusal or bedrock, whichever is first, with split-spoon samples collected continuously. Upon extraction from the ground, each sample will be screened using a Thermo Environmental 580B Organic Vapor Meter (OVM). A portion of each sample collected will be placed in a sealing polyethylene bag for headspace analysis approximately 15 minutes following collection.

Soils recovered by the split-spoon sampling device will be deposited in a properly decontaminated stainless steel mixing bowl and homogenized prior to placing the soils in approved, method-specific sample containers. Specific analytical methods for subsurface samples collected during this Remedial Investigation are as follows:

- Inorganics (13 metals plus Cyanide, Phenols, Chloride, Sulfide)
- Volatile Organics, Method 8260
- Extractable Organics, Method 8270
- Pesticides/Herbicides, Method 8080

Each sample container will be properly labelled and custody seals will be affixed before placing the containers in protective bubble-wrap sleeves. The sample containers will then be placed in rigid insulated coolers on ice and maintained in such condition until received by the analytical laboratory. Prior to shipment, all sample chain-of-custody documentation will be completed and custody seals will be affixed to the cooler as described by the Quality Assurance Project Plan.

Portions of soils recovered by the split-spoon sampling device and/or soils retained for headspace analysis of organic vapor will be used for soil classification in accordance with the Order. Soils will be described in accordance with the Unified Soil Classification System, ASTM D 2487. Should soils which may act as a confining layer be encountered, shelly tube samples may be collected for assessment of hydraulic conductivity and/or other physical properties. As each boring will terminate at or above bedrock, no rock cores will be collected during this investigation.

4.3 SURFACE WATER/SEDIMENT

There are no natural surface water bodies within the boundaries of the subject site. The nearest natural surface water bodies are located approximately 1,600 feet to the northwest of the residue stockpile. The Chicago Sanitary and Ship Canal is located approximately 2,200 feet to the northwest of the stockpile, and the Des Plaines River is approximately 3,600 feet northwest of the stockpile. Due to the remote location of each of these watercourses and the extent of nearby or adjacent industrial activity, no sampling or assessment of any of these natural surface water bodies will be conducted during this Remedial Investigation.

Localized drainage patterns in the area of the residue stockpile are influenced by access roadways to facility operations. Drainage swales along these roads generally drain to the north and east before entering the former recirculation pond. This basin measures approximately 70 feet by 625 feet, with a water surface elevation of 599.5 N.V.G.D. The basin was constructed by former owners/operators of the subject site along the north margin of the property, and at one time served to collect and retain storm water for use in the shredding process. At present, this basin collects only storm water from the residue stockpile area and surrounding operations. As referenced in the Order, this basin was the subject of previous investigation by the Respondent and representatives of the Illinois EPA. Samples of sediment from the bottom of this basin were collected and analyzed in accordance with the work plan presented to IEPA. Copies of these analytical determinations are presented in Appendix B. Due to the absence of target analytes at concentrations of concern, no further assessment of this basin was required by IEPA and none will be conducted during this Remedial Investigation.

Drainage ditches leading to this basin contain or have contained various scrap metal articles, debris and/or shredder residue over the operational history of this site. Water may stand in some portion of these drainages, due to obstruction or water surface elevation within the basin, at any given point in time. The Respondents propose to collect five (5) sediment samples within the drainages serving the stockpile area. If accessible to sampling equipment (drill rig or push-probe rig), subsurface samples will be collected to a maximum depth of ten (10) feet at each sediment sample location. Subsurface soil samples will be collected in a manner consistent with that represented in Section 4.2 above to assess whether any vertical migration of chemical constituents has occurred within the drainage pathway.

As no natural water bodies or drainages are undergoing analysis as part of this investigation, physical and chemical properties of area waters will not be addressed. Physical and chemical properties of sediment within the drainage pathway may be assessed during this investigation. These properties will include pH, grain size, specific gravity, organic carbon content and total metals concentration. Due to the absence of organic constituents of concern in basin sediment samples collected with IEPA, Respondents will not analyze sediment samples collected during this Remedial Investigation for organic constituents.

5.0 SOURCE CHARACTERIZATION

The existing shredder residue stockpile has been identified as hazardous waste within the Order issued by Region 5. The Respondents do not believe that sufficient data exists to support this assertion, and will further characterize material within this stockpile as part of this Remedial Investigation. W.Z. Baumgartner & Associates, Inc. will implement a random, three-dimensional sampling plan to characterize this material.

5.1 SELECTION OF SAMPLE LOCATIONS

Previous aerial survey of the subject site will be utilized to establish a grid pattern across the stockpile. This grid will consist of lines intersecting at right angles and spaced 50 feet apart. This spacing will result in approximately 100 grid intersections across the pile. A random number generator function contained within a handheld scientific calculator will be used to identify grid areas subject to sample collection. Forty (40) percent of the grid intersections will be selected for sampling, and the vertical depth of sample collection will also be assigned using the random number generator function. Due to the depth of the stockpile (>45 feet), sample collection depths will be limited to less than 20 feet below the pile surface to allow for the use of conventional excavation machinery. This method will allow for random, three-dimensional sampling of the maximum extent of the pile which is practically accessible to the sample collection team. The procedure satisfies the random sampling approach described in SW-846, Chapter Nine. Sample locations will be revised, as appropriate, in any subsequent phases of the characterization.

5.2 SAMPLE COLLECTION

Solid matrix samples will be collected in individual five gallon plastic pails from each randomly selected grid intersection and at the prescribed depth interval. Surface samples will be collected by hand and may or may not involve assistance from heavy equipment at the sampling teams' discretion. At no time will sampling team members enter an excavation or pit which exceeds four feet in depth without adequate shoring of the excavation and/or removal of material outside an estimated angle of repose. This angle typically exceeds 60° in most residue stockpiles; however, site-specific conditions will be considered in evaluation of each sample location.

Individual sample collection will be performed by hand in order to obtain a representative sample from the selected interval. Each aliquot will consist of multiple small volume samples selected to create a five gallon sample volume. Following collection of all samples required by this Plan, the sampling team will proceed to an appropriate area onsite where preliminary sample homogenization and containerization of individual aliquots may be conducted.

5.3 PRELIMINARY SAMPLE PREPARATION

The contents of each individual sample will be emptied upon polyethylene sheeting or plywood decking and thoroughly mixed by hand. Some particle size reduction may be conducted on-site by the sampling team using hand shears to ensure the representativeness of individual sample aliquots assembled from the material collected. Any large items which

cannot be reduced in size using hand shears and are not necessarily consistent with the balance of the material collected, such as large sheet metal fragments, may be discharged at the sampling teams' discretion.

Individual sample aliquots of approximately one gallon each will be prepared from the material blended as stated above. The material will be spread to a uniform depth over the working surface and quartered. Equal volume portions of each quarter will be placed in individual sample containers to create two individual sample aliquots. Each sample will be shipped to the offices of W. Z. Baumgartner & Associates, Inc. for processing. One sample will be subjected to analysis and the other will be retained as determined by a random number selection process. The balance of material will be returned to the original pail and sealed for secure storage at the Summit site. At sample locations determined in the field, this remaining sample will be used to prepare matrix spike and matrix spike duplicate samples. All samples will be provided with custody seals prior to shipment to the offices of W. Z. Baumgartner & Associates, Inc. Field sample collection data sheets, photographs and chain-of-custody documentation will be completed and forwarded to the recipient, as appropriate.

5.4 SAMPLING EQUIPMENT

It is expected that the following equipment will be necessary during this sampling event:

- Excavator; Caterpillar 229D or equivalent and operator
- Forty (40) each Plastic Pails, 5 gal. capacity with locking lids

- One (1) steel shovel
- One (1) pick axe/mattock
- Two (2) steel trowels
- One (1) 4'x8'x½" CDX plywood
- Two (2) sawhorses (drums optional)
- One (1) roll polyethylene sheeting
- Personal Protective Equipment (PPE)
 - Gloves, Leather/Canvas
 - Gloves, Rubber/Latex
 - Tyvek coveralls
 - Footwear, steel toe
 - Safety glasses
 - Hardhat
 - Other as required by site specific Health and Safety Plan

Other equipment may be necessary due to unforeseen site conditions. The equipment list may be amended as required.

5.5 SAMPLE PRESERVATION

Individual sample aliquots and method spike/method spike duplicate (MS/MSD) samples will be placed in one (1) gallon, heavy duty self-sealing plastic bags. Samples will be shipped to the office of W. Z. Baumgartner & Associates, Inc. in rigid insulated coolers. Immediately following pre-cooling of samples in a separate cooler filled with ice, samples will

be packed in an insulated cooler for shipment. Self-sealing plastic bags containing ice will be placed with the solid matrix samples and shipped overnight via commercial parcel service or same-day via commercial airliner. No preservation methods other than cooling will be required by this Plan.

5.6 SAMPLE PROCESSING

As described in Section 5.3, solid matrix samples will be subject to physical mixing and limited particle size reduction in the field to facilitate homogenization of sample material prior to preparation of individual samples for shipment. Upon arrival at the office of W. Z. Baumgartner & Associates, Inc., receipt of each shipping container will be recorded and dated and the sample receipt log will be initialed by the parcel delivery person. Sample processing will be conducted in accordance with Section F, Sample Processing and Analysis of the *Sampling, Analysis and Data Review of Shredder Residue* document prepared by W. Z. Baumgartner & Associates, Inc. and attached as Appendix C. Mechanical devices such as grinders or hammer mills will not be allowed for sample processing under this Plan. Processing will satisfy sample size requirements of EPA document SW-846, *Test Methods For Evaluating Solid Waste, Physical/Chemical Methods (Third Edition)*.

5.7 ANALYTICAL DETERMINATIONS

Elevated levels of leachable lead are referenced in the Order. The main objective of Section 5.0, Source Characterization, is to determine the physical and chemical properties of shredder residue stockpiled at the subject site. Based upon process knowledge, the experience

of W. Z. Baumgartner & Associates, Inc. in characterization of shredder residue and previous investigations of similar material by Others, the Respondents propose limited assessment of physical and chemical properties of the stockpiled material.

5.7.1 PHYSICAL DETERMINATIONS

Three (3) composite samples of stockpiled shredder residue will be collected as part of the source characterization. Each composite sample will be processed in accordance with the procedures described in Appendix C and subjected to the following physical determinations:

- Particle Size Distribution
- Bulk Density
- Composition by Recognizable Component
- Organic Content (Volatile Solids)
- Mineral Content (Ash)

The results of each physical determination will be presented in exhibit form and included in the Remedial Investigation Report.

5.7.2 CHEMICAL DETERMINATIONS

Chemical constituents of concern in shredder residue are generally limited to inorganics, namely lead. In order to develop the necessary level of comfort with

respect to contaminant migration, Respondents propose to analyze three (3) composite samples of stockpiled shredder residue for the following:

- Inorganics (13 metals plus Cyanide, Phenols, Chloride, Sulfide)
- Volatile Organics, Method 8260
- Extractable Organics, Method 8270
- Pesticides/Herbicides, Method 8080
- Reactivity
- Corrosivity
- Ignitability
- Paint Filter

Respondents do not propose to conduct any Toxicity Characteristic Leaching Procedure (TCLP) organics analyses, as the analytes in question are rarely reported at total concentrations above the report limit. Should more comprehensive analysis be required in the future for offsite disposal, such data may be generated at that time.

Each randomly selected grid sample will be processed in accordance with the procedures described in Appendix C and analyzed as follows:

- Total lead, Method 6010
- TCLP lead, Method 1311/6010

5.8 DATA REVIEW STOCKPILE

W. Z. Baumgartner & Associates, Inc. will assemble data reported as a result of this sampling event. The regulatory threshold for the target analytes will be as follows:

TCLP Lead	5.0 mg/l
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Should the simple arithmetic mean of the target analyte concentration be less than the regulatory threshold stated above, the material will be deemed suitable for placement in a Subtitle D solid waste disposal facility by U.S. EPA and the responsible parties will be provided with written confirmation by U.S. EPA stating the shredder residue stockpiled on the Summit site is approved for disposal in a Subtitle D facility. Individual sample exceedances of the regulatory threshold will not be considered for characterization and isolation of certain segments of the stockpile. Should the simple arithmetic mean of the data exceed the threshold, the data will be subjected to further scrutiny, following Exhibit No. 1. One or more additional phases of sampling may be undertaken, if necessary, to further characterize the stockpile if the statistical analysis referred to above yields results in excess of the regulatory threshold. If such additional phases are necessary, all work will be performed according to the protocols set forth in this sampling plan.

6.0 CONTAMINATION CHARACTERIZATION

Contamination resulting from the shredder residue stockpile will be addressed during this Remedial Investigation. Due to the physical properties and consistency of shredder residue, which cause difficulty when using conventional auger rigs as well as push-probe rigs, no soil borings will be advanced through the stockpiled material. Soil borings will be installed adjacent to the stockpile to assess surface and subsurface conditions in the immediate vicinity of the stockpile, and additional borings will be completed at remote locations to ascertain the extent and magnitude of contaminant migration from the stockpile as well as upgradient conditions. A number of these borings may be completed as groundwater monitoring wells as represented in Figure 2.

6.1 SOIL BORINGS

Respondents propose to install a total of ten (10) soil borings during this Remedial Investigation. Five (5) of these soil borings will be immediately adjacent to the shredder residue stockpile as shown in Figure 2. The remaining borings will be completed at distances ranging from approximately 200 to 800 feet from the pile. Each of these remote soil borings will be completed as a groundwater monitoring well in order to establish groundwater flow direction, gradient and rate, should groundwater be encountered. Three (3) of the five (5) borings adjacent to the stockpile will be completed as monitoring wells in order to define constituent concentrations at the suspected source.

6.1.1 INSTALLATION

Soil borings will be completed using applicable rotary drilling equipment or push-probe technologies. Continuous split-spoon samples will be collected at each boring location to groundwater, refusal or bedrock, whichever is encountered first. Split-spoon samplers will be hand washed using laboratory grade phosphate-free detergent and tap water before each use. Sampling devices and augers will be steam-cleaned between each soil boring location.

Soil samples will be provided by the drilling contractor to the engineer or geologist in charge of sample collection. Auger cuttings, excess soil or other waste generated during boring installation will be placed on 6 mil polyethylene sheeting. Prior to completion of the drilling phase of the Remedial Investigation, the drilling contractor will transfer these soils to 17-H welded steel 55 gallon drums for storage. Each drum will be labelled accordingly and will remain adjacent to the soil boring location.

6.1.2 SAMPLE COLLECTION

Split-spoon samplers will be driven continuously (in advance of the augers, where applicable) at each soil boring location. Upon retrieval from the boring/probe annulus, the drilling contractor will separate the sampling device from the sampling rods, loosen the sampler nose cone and hand the sampler to the supervising engineer/geologist. The sampler will be taken to an adjacent area, where the device

will be opened and the recovered soils visually inspected. The soils may be screened for organic vapor prior to removal from the sampler.

Soils will be removed from the sampler and placed in a stainless steel mixing bowl, where the sample will be homogenized by hand. Stainless steel spoons, trowels or other hand tools may be used in sample preparation. Once homogenized, the sample will be placed in pre-cleaned, method-specific sample containers, labels will be completed and custody seals will be affixed. For analyses proposed by this Workplan, two (2) 4 oz. glass jars with teflon-septum lids will be adequate. In addition, soils from each subsurface sample interval will be placed in sealing polyethylene bags for organic vapor screening.

6.1.3 SAMPLE IDENTIFICATION

Each sample will be identified with a unique sample identification code. This sample identification code will be placed on the container label using a permanent, waterproof black marker. Sample identification codes will consist of the following information:

-Initial entry: Sample Type

SR-Shredder residue

SS-Sediment sample

SB-Soil boring

-Next entry: Location

Number unique to above sample type

-Next entry: Sample depth 01-Sediment sample; depth below ground surface

e.g. SS-03-01 Sediment sample location 3

e.g. SB-01-08 Boring 1, soil 6-8 ft. b.g.s.

These unique sample identification codes will be placed on each sample container. In addition to the sample identification code, the supervising engineer/geologist will also complete the balance of the sample label. Required information will include sample collection date, sampler, project number and sample matrix.

6.1.4 SAMPLE PRESERVATION AND SHIPPING

Solid matrix samples collected during this Remedial Investigation will be preserved by cooling. No chemical preservatives or other sample preservation methods are required. All samples will be precooled a minimum of 15 minutes by placing sample containers in a separate insulated cooler containing ice. Precooling of solid matrix samples is required where protective bubble wrap shipping sleeves are used, as these sleeves may serve to insulate the sample container during shipment.

Each properly labeled, sealed and precooled sample container will be placed inside protective bubble-wrap sleeves prior to placement within a rigid insulated cooler for shipment to the offices of W.Z. Baumgartner & Associates, Inc. for sample logging and delivery to the analytical laboratory. Additional protective packaging will

be utilized as necessary to ensure sample containers are received at the laboratory with a minimum of damage or breakage.

6.1.5 CHAIN-OF-CUSTODY AND SHIPPING REQUIREMENTS

All soil and groundwater samples collected during this Remedial Investigation will be shipped to the office of W.Z. Baumgartner & Associates, Inc. using one of two shipping alternatives. The first shipping option involves the use of commercial carriers, such as Federal Express or United Parcel Service, offering overnight delivery. The second option is use of commercial airline freight service. In either instance, time is of the essence and all soil and groundwater samples will be shipped for priority overnight or same-day delivery.

Sample chain-of-custody documents will be completed pursuant to the provisions of the Quality Assurance Project Plan and standard convention for environmental assessment. Chain-of-custody forms will be completed in the field and placed inside the shipping container or within a document pouch affixed to the exterior of the shipping container. As custody seals and temper-evident sealing tape is used on shipping containers, it is not required that shipping company personnel make entries on the custody record. Delivery personnel are required to initial the Sample Receipt Log at the offices of W.Z. Baumgartner & Associates, Inc. to verify the time and date of parcel delivery. All shipments received are identified by project number, company/project name, carrier and date.

6.1.6 ABANDONMENT

Each soil boring not completed as a groundwater monitoring well following collection of all necessary soil samples will be abandoned in accordance with sound work practice and the requirements of the IEPA. At a minimum, well abandonment will consist of filling the borehole annulus with bentonite, neat cement or cement-bentonite grout. Grout will be placed to within one (1) foot of the ground surface, and surrounding soils or cuttings will be used to bring the borehole to grade.

6.1.7 SAMPLE ANALYSIS

Soil samples collected during the Remedial Investigation will be analyzed in accordance with the provisions of this section and the requirements of the Quality Assurance Project Plan. Samples collected from the 0-2 foot, 2-4 foot, 4-6 foot and 8-10 foot sampling intervals will be analyzed for the following parameters/methods:

- Inorganics (13 metals plus cyanide, phenols, chloride, sulfide), Method varies
- Volatile Organics, Method 8260
- Extractable Organics, Method 8270
- Pesticides/Herbicides/PCB, Method 8080/8150/8080

Media specific screening levels are presented in the QAPP. Additional soil sample intervals may be subject to laboratory analysis based upon organic vapor

readings, odor, visible staining or other field indicators, at the discretion of the field sampling staff. The above methods will also be employed in analysis of blanks, duplicates, replicates or other quality control samples.

6.2 GROUNDWATER

As described in Section 6.1, eight (8) of ten (10) soil borings will be completed as groundwater monitoring wells. The location of each is shown in Figure 2. These wells will be constructed in accordance with the requirements of the IEPA and Illinois Geologic Survey, as appropriate, and under the direct supervision of a geologist and/or engineer. These groundwater monitoring wells will be constructed of two (2) inch polyvinyl chloride (PVC) well materials and completed as shown in Figure 8-1 of the Field Sampling Procedures Plan. The locations will be selected based upon anticipated groundwater flow direction, pile orientation, surface water flow direction and historical site operations.

6.2.1 INSTALLATION

Upon reaching the potentiometric groundwater surface and following collection of all necessary soil samples, the engineer or geologist will direct the driller to advance the augers to a depth approximately eight (8) feet below the groundwater surface. The driller will then prepare well materials for insertion. Unless otherwise directed, all wells will be constructed through the stem of the augers.

Ten (10) foot screens with slot sizing of 0.010 inch will be used at each well.

Well screen and riser will remain in protective plastic packaging throughout the well assembly process to the maximum extent practical. PVC end cap/silt trap, locking plug and padlock will be installed prior to lowering the well materials into the augers. All personnel handling well materials will wear clean vinyl or latex surgical gloves, and a surgical glove will be placed over the locking plug to prevent sand from fouling the padlock mechanism.

Once the well materials have been assembled and lowered in to the auger stem, the driller will begin adding the sandpack. The specifications for sand used to construct the sandpack will be submitted by the driller for approval by the engineer. The driller will use tremie pipe if necessary to ensure all sand placed down the stem reaches the screened interval, and the driller will monitor the depth of sand within the augers with a fiberglass or steel tape before raising/extracting augers from the borehole.

Upon bringing the sandpack to a point at least two (2) feet above the top of the screen, the driller will seal the annulus with a granular or powdered bentonite product. The bentonite seal will be a minimum of two (2) feet in thickness and will be immediately followed by additional bentonite or bentonite/cement grout to a depth approximately two (2) feet below the ground surface. At this point, the well will be completed with a flush mount or upright protective casing as shown in Figure 8-1.

6.2.2 WELL DEVELOPMENT

Each well will be developed following installation. Well development will consist of withdrawal of the maximum practical volume of groundwater from a given well or until water removed from the well is substantially free of suspended solids. Development water will be pumped using hand pumps, vacuum pumps or submersible, centrifugal pumps. Bailers will not be used for well development unless site-specific conditions preclude the use of other well development devices.

All development water will be placed in 17-H welded steel 55 gallon drums. Each such drum will be labeled accordingly. Following development, the drum will be bunged and remain at the well location for future use in storage of purge water.

6.2.3 PURGING AND SAMPLE COLLECTION

Each well will be purged prior to collection of groundwater samples for laboratory analysis. Acceptable purging devices include teflon bailers, bladder pumps, peristaltic pumps and submersible, centrifugal pumps. Associated materials, such as bailer line, suction tubing and discharge tubing, must be discarded between wells or amenable to decontamination.

Upon arrival at the wellhead, the protective casing will be opened and the padlock attached to the locking plug will be removed. Once the plug is removed and set aside, the depth to groundwater will be measured using an electronic tape, or slope

indicator. The depth to water is documented and, based on the known total depth of the well, the volume of water within the well casing is calculated. This volume, as well as other necessary information, is recorded on the Sample Collection Summary Sheet. Field sampling staff will remove this volume of water from the well repeatedly until such time as field parameters have stabilized. Field parameters to be monitored include the following:

- pH
- Temperature
- Specific Conductance
- Turbidity

A minimum of three (3) well volumes will be removed from each well prior to sample collection. Water removed during the purging process will be measured using a container of known volume, and will be placed in the development water storage drum.

Following stabilization of field parameters or the determination that these parameters are unlikely to stabilize within a reasonable period of time, the field sampling staff will complete the purging section of the Sample Collection Summary Sheet and prepare for sample collection. Sampling equipment, sample containers and associated materials will be prepared following donning of clean surgical gloves. Acceptable sample collection devices include teflon bailers, peristaltic pumps and bladder pumps. If reintroduced to the well following purging (i.e. bailer), the

sampling device should be lowered into the well so as to cause a minimum of disturbance. Sample containers will be filled in the order represented below:

- Metals
- Volatile Organics
- Extractable Organics
- Pesticides/Herbicides/PCB
- Inorganics

Upon filling individual sample containers to the proper level, the lid will be secured, the label completed and custody seals affixed. Following removal of all sampling devices and materials, the padlocking locking plug is returned to the well casing and the protective casing is secured. Groundwater samples will be visually inspected following collection and comments recorded as appropriate on the Sample Collection Summary Sheet. The samples will be precooled, preserved and shipped for analysis consistent with Sections 6.1.4 and Section 6.1.5 above.

6.2.4 SAMPLE ANALYSIS

Groundwater samples collected during the Remedial Investigation will be analyzed in accordance with the provisions of this Section and the requirements of the Quality Assurance Project Plan. Groundwater samples will be analyzed for the following parameters/methods:

- Inorganics (13 metals plus cyanide, phenol, chloride, sulfide), Method varies
- Volatile Organics, Method 8260
- Extractable Organics, Method 8270
- Pesticides/Herbicides/PCB, Method 8080/8150/8080

Media specific screening levels are presented in the QAPP. These methods will also be employed in analysis of blanks, duplicates, replicates or other quality control samples.

6.3 SURFACE WATER AND SEDIMENT

As discussed in Section 4.3 of this Workplan, there are no natural surface water bodies located on the subject site. Natural surface water bodies which could potentially be affected are greater than 1,500 feet to the northwest of the shredder residue stockpile, and storm water runoff is not believed to enter these waters directly. Due to the prevalence of industrial activity in the area in general and immediately adjacent to the subject site, the Respondents will not attempt to characterize contamination in offsite surface water bodies as part of this Remedial Investigation.

Section 4.3 documents prior investigation and sampling of sediments from the former recirculation basin. Water samples collected during this previous investigation were analyzed for TCLP Method 1311 parameters only. Respondents propose to collect a single surface water sample from the basin in question and analyze same in accordance with the analytical methods provided in Section 6.2.4 above.

In addition to the above analyses, Respondents will further characterize storm water contained in the basin by analyzing a single water sample for the following parameters:

Parameter	Cut-Off Concentration (mg/l)
- Chemical Oxygen Demand	120
- Total Suspended Solids	100
- Total Recoverable Aluminum	0.75
- Total Recoverable Copper	0.0636
- Total Recoverable Iron	1.0
- Total Recoverable Lead	0.0816
- Total Recoverable Zinc	0.117

The above parameters are taken from the Multi-Sector NPDES General Permit drafted by U.S. EPA for scrap metal recycling facilities, SIC 5093. The water sample collected during this Remedial Investigation will be analyzed for the above parameters and the results compared to the cut-off concentration.

7.0 POTENTIAL RECEPTOR IDENTIFICATION

Respondents will collect available data on human populations and ecological systems currently or potentially at risk as a result of the facility. Respondents will make a reasonable effort to obtain access to local, state and federal records which are deemed of such quality or content as to provide useful information with respect to the Remedial Investigation. This information may be solicited in person, by mail or via electronic means. Issues to be addressed are itemized below.

7.1 GROUNDWATER UTILIZATION

Respondents will contact the Village of Summit, City of Chicago or other local utilities regarding current and anticipated groundwater utilization. Respondents will also review Illinois Geological Survey and IEPA well records to determine the size, location, depth and yield of any nearby domestic, agricultural or industrial groundwater wells. Wells located within one-half mile of the center of the subject site will be considered nearby wells. Preliminary contact with the Village of Summit suggests a prohibition on groundwater use is in effect at this time.

7.2 SURFACE WATER UTILIZATION

Area surface waters are primarily used for commercial, industrial and recreational purposes. The Chicago Sanitary and Ship Channel is located between the subject site and the Des Plaines River. Available information will be solicited such that more definitive

assessment of current and anticipated surface water utilization may be conducted. Agencies to be contacted will include IEPA, EPA, Cook County Health Department and the Illinois Department of Natural Resources.

7.3 SITE ACCESS/HUMAN USE OF ADJOINING LANDS

Site access is restricted through the use of fences and security staff. Adjoining properties are industrial or commercial in nature, with limited residential or recreational uses identified at present. Information regarding the presence of parks, golf courses, wildlife management areas, refuges, forest preserves and other recreational lands will be provided. In addition, residential areas will be identified and the location represented on exhibits provided in the Remedial Investigation Report.

7.4 DEMOGRAPHICS

Respondents will make a reasonable attempt to obtain and review U.S. Census records and any available Cook County and Village of Summit records. Because of the active nature of the site, human access to same has in the past generally been limited to employees, subcontractors and visitors of the Respondents and their predecessors. The age of these persons generally ranges from 18 to 60 years and the vast majority of those persons entering the active portions of the site are male. Numerous ethnic groups are or have been a part of the workforce at the subject site, and available records will be reviewed and commented upon in the Remedial Investigation Report.

Demographic profile of unauthorized persons entering the site will be limited to review and comment on available census records. As the age, sex, ethnic background and location of residence for unauthorized entrants to the site is not reasonably ascertainable, Respondents will provide available information on residential areas most proximate to the site.

7.5 ECOLOGICAL SURVEY

The aforementioned local, state and federal resources and agencies will likewise be contacted regarding the likelihood or known presence of threatened or endangered species on or near the subject site. Due to the long-term industrial use of the subject site, no significant habitat or species are known or believed to be present on the site. Respondents will provide available information and site-specific observations within the final report.

Midwest Metallica L.P. and S. D. Metals, Inc. will be responsible for overall project management and reporting to EPA. The Project Coordinator is Terence J. Coogan, Esq., General Counsel for Midwest Metallica L.P. The Project Coordinator will represent the Respondents with respect to general project management issues, will prepare periodic project status reports and will direct the preparation and submittal of all reports and other documentation. Project organization and responsibilities are more fully described in Section 2 of the Quality Assurance Project Plan (QAPP). Figure 2-1 of the QAPP presents an organizational chart identifying responsible individuals and organizations with respect to this remedial investigation.

9.0 QUALITY ASSURANCE PROJECT PLAN

The Quality Assurance Project Plan (QAPP) has been developed by the Respondents to document all sample collection, sample analysis and field measurements to be performed during this Remedial Investigation. Methods and techniques to be employed during the Remedial Investigation are approved by U.S. EPA. The QAPP has been prepared in accordance with guidance documents provided by Region 5, including *U.S. EPA RCRA QAPP Instructions* and *The Use of Field Methods to Support RFI Streamlining*, where appropriate. A copy of the QAPP is provided as a separate document.

10.0 DATA MANAGEMENT PLAN

Data management is discussed throughout the QAPP. Midwest Metallics, L.P., S.D. Metals, Inc. and their consultants and subcontractors will implement those measures outlined in the QAPP to ensure that data generated during the Remedial Investigation is of such quality and precision that decisions relative to remedial actions and future utilization may be taken.

As field work is completed, W. Z. Baumgartner & Associated, Inc. will take data reported by the analytical laboratory and/or field sampling staff and organize same in such a manner as to facilitate review by Midwest Metallics, L. P., S. D. Metals, Inc. and Region 5 EPA. Data and findings generated during the Remedial Investigation may be submitted in narrative, tabular and/or exhibit form, as appropriate.

The Project Coordinator will be responsible for review, approval, and correspondence of all findings to EPA. The Project Coordinator will also submit or direct the submission of periodic project updates to Region 5 as required by the Order.

11.0 HEALTH AND SAFETY PLAN

Attached as a separate document is the Health & Safety Plan as developed by W.Z. Baumgartner & Associates, Inc. This document has been developed to address known and/or potential health and safety issues at the subject site and within specific work areas. This Plan will serve as a supplement to the Corporate Health & Safety Plan developed by W.Z. Baumgartner & Associates, Inc. for its employees and to health and safety plans developed by any other contractors or subcontractors engaged in activities associated with this Remedial Investigation. All site workers engaged in remedial investigation activities will provide documentation of 40 hour OSHA certification and 8 hour refresher training (as applicable).

Prior to initiation of daily site activities, staff, contractors and subcontractors will assemble for a daily safety briefing. Site workers will be briefed on known or potential safety issues and asked for input regarding site safety of work practices. Each person present at this briefing will register their attendance prior to beginning work for the day.

Throughout the work day, all site workers will comply with the terms and conditions of the Plan. Failure to do so may result in removal from the site. All site workers will undergo decontamination procedures as set forth in the Plan prior to leaving the site for any reason.

12.0 REMEDIAL INVESTIGATION SCHEDULE

TIMELINE FOR IMPLEMENTATION OF THE RI WORKPLAN (days noted below are est.)

- Following acceptance and approval of the Draft RI Workplan by Region 5:

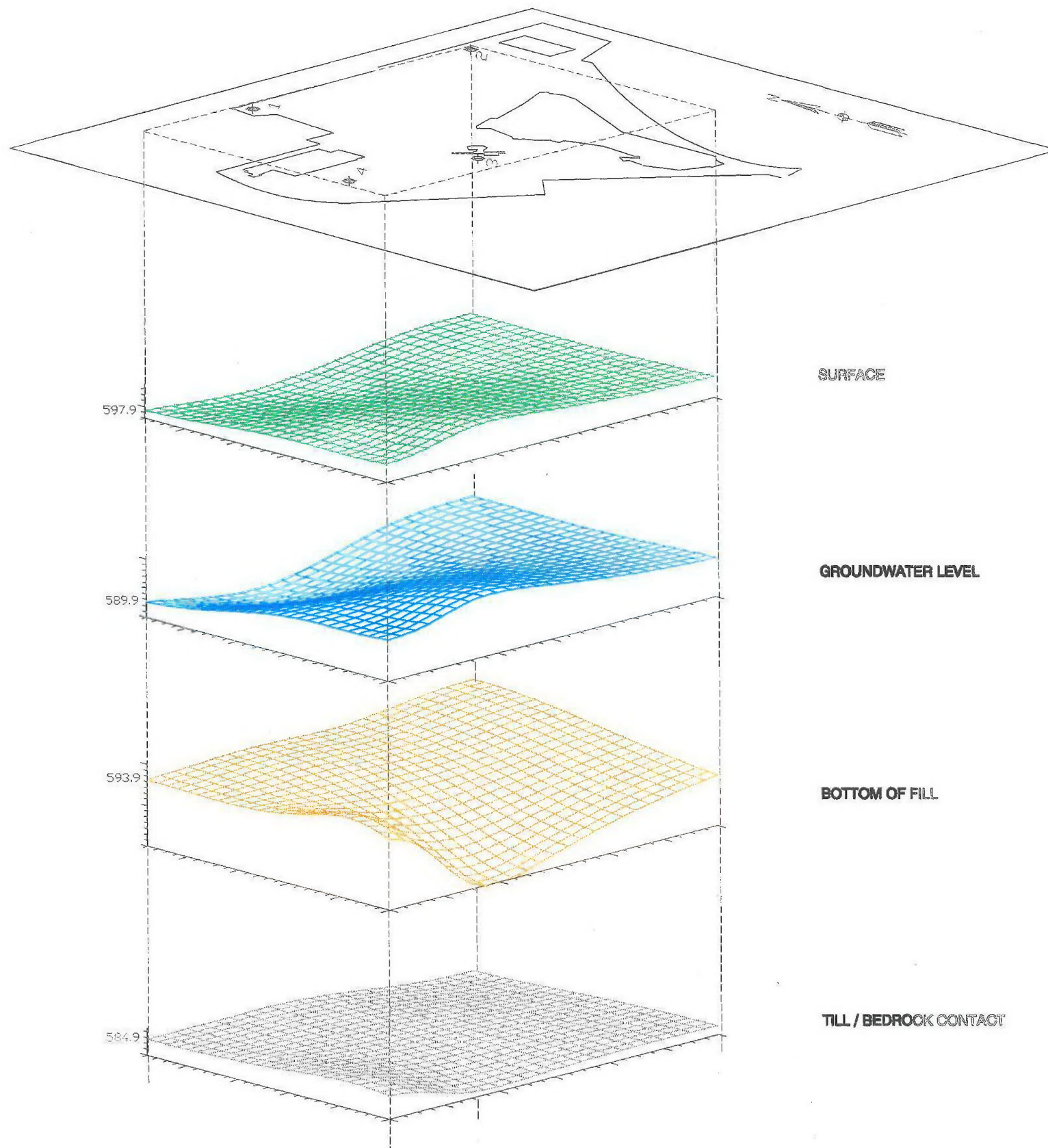
- Day 1 Authorize consultant to initiate RI per workplan
 Consultant contact w/ potential subcontractors(including OneCall)
 Consultant schedules site visits as required

- Day 15 Consultant reconnaissance of site to identify any conflicts
 Conduct limited air sampling
 Review utilities as located by Others
 Establish sampling grid on stockpile
 Establish soil boring/well locations

- Day 30 Initiate stockpile characterization
 Initiate soil boring/well work

- Day 35 Complete stockpile sample collection
 Residue samples shipped to WZB for processing
 Soil boring/well work continues
 Development of monitoring wells
 Site-specific data gathering continues

- Day 40 Complete soil boring/well work
Continue development of monitoring wells
Shredder residue samples received at WZB
- Day 41 Soil samples received at WZB
- Day 45 Soil samples submitted for analysis and/or extraction, as appropriate
Shredder residue samples processed and submitted for analysis
- Day 60 Initial data reporting
Initial data reduction and interpretation
- Day 120 DRAFT RI REPORT prepared for Respondent review
- Day 150 DRAFT RI REPORT submitted to EPA



SURFACE

GROUNDWATER LEVEL

BOTTOM OF FILL

TILL / BEDROCK CONTACT

BAR IS ONE INCH ON
ORIGINAL DRAWING
IF NOT ONE INCH ON
THIS SHEET, ADJUST
SCALES ACCORDINGLY

W. Z. BAUMGARTNER & ASSOCIATES, INC.
ENVIRONMENTAL CONSULTANTS
600 WILSON PIKE CIRCLE, SUITE 206
P. O. BOX 786 (37024)
BRENTWOOD, TENNESSEE 37027
615-378-1572

DRAWN BY: BM/CLG
CHECKED BY: BM
ENGINEER: WZB
DATE: 9/15/98

HYDROGEOLOGY DIAGRAM



SCALE:	PROJECT NO:
NONE	97031
CONTOUR INTERVAL:	FIGURE NO:
NA	5

NO.	REVISIONS	DATE	ENGR

APPENDIX A

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STATEMENT OF QUALIFICATIONS

W. Z. Baumgartner & Associates, Inc. is a multidisciplined industrial environmental engineering and consulting firm that concentrates on assisting the scrap metal and recycling industry. The firm provides a complete range of consulting services which include:

1. *Storm Water Control (Section 402P - CWA 1987)* - Design of drainage and treatment facilities, oil water separators; preparation of Storm Water Pollution Prevention Plan (SWPPP) and Best Management Plans .
2. *Site Environmental Compliance Reviews/Assessments/Audits* - Confidential site investigations, sampling of soil, water, and air as appropriate; preparation of Risk Factor Reports.
3. *Spill Prevention Control and Countermeasure Plans (40 CFR 112)* - Design of oil spill control containment systems, oily water runoff treatment and control, including N.P.D.E.S. compliance programs. Compliance with above ground storage requirements.
4. *"SUPERFUND," "R.C.R.A.," and "ECRA" Consultation* - Closure Plans, and permit applications, coordination with State and Federal agencies; groundwater programs.
5. *PCB Source Identification Training Seminars*
6. *UST* - Underground tank compliance programs, closure/removal programs; monitoring.
7. *Right-to-Know Consultation* - SARA Title III, Employee and Community Hazard Communications Plans
8. *Solid Waste Landfills* - Design of industrial landfills, including several exclusively for shredder waste; consulting and laboratory analysis for acceptance of waste to landfills, leachate control systems; design of groundwater quality monitoring systems; closure plans for shredder waste landfills.

The firm's professional staff is licensed in thirty-two states and have worked with over four hundred scrap metal and related facilities. The firm has conducted research for the Institute of Scrap Recycling Industries, the Automobile Metal Recycling Association of New Jersey and the Partners for Plastic Progress (PPP).

The firm has designed solid waste monofills for economic disposal of shredder residue (SR), performed landfill simulation studies and convinced state regulatory agencies to accept scrap yard waste streams as alternate landfill cover material. W. Z. Baumgartner & Associates, Inc. pioneered shredder waste monitoring programs and the firm's sampling and testing procedures have been adopted by the Commonwealth of Massachusetts and approved for use in the states of Illinois, New Mexico, Texas, Arizona, New Jersey and Mississippi.

The firm was engaged by the Institute of Scrap Recycling Industries and commissioned to prepare a study on the physical and chemical characteristics and management of shredder waste entitled *Shredder Residue: Environmental Information and Characterization Under RCRA* published in 1992. The firm's *Best Management Plan* for management of shredder residue has been approved by the Commonwealth of Massachusetts and was adopted as the official state plan by the State of Arizona in 1993. Our professional staff served, at the request of the State of Florida, on the Technical Advisory Group for the management of shredder residue.

Following are descriptions of past projects which demonstrate the firm's experience in the environmental field:

Schrader Automotive Sites - Dickson County, Tennessee - Superfund

This project involved a total of five (5) different sites. The main site was a manufacturing facility that had been closed for about four (4) years at the time the site was listed on the NPL. The facility had manufactured automotive parts and operated several metals finishing production lines. Wastewater was treated on-site prior to discharge to the city sewer. For several years after the wastewater treatment system was built, sludge from the system was buried in a permitted landfill located on the plant property. At other times, the sludge was transported to four other dumping sites in the county and used for fill material on farmland.

W Z B

The sludge was subsequently determined to be a hazardous waste. As part of the main site evaluation phase a series of groundwater monitoring wells (total network included seven wells) were installed. These wells were monitored until sufficient data was available for statistical analysis and determination of the site impact on the groundwater. A mapping process was conducted to locate each of the waste cells and to estimate the volume of sludge on-site.

The feasibility study for the site indicated that excavation of the waste and removal to a Subtitle C landfill was necessary due to the leachability of the waste and the geology of the area.

A detailed remediation plan for all five sites was developed by W. Z. Baumgartner & Associates, Inc.. Following approval of the plan, W. Z. Baumgartner & Associates, Inc. assisted the owner and the Tennessee Division of Superfund in contracting for remediation services.

Boston Industrial Products - Hohenwald, Tennessee - RCRA

This facility used a several million gallon surface impoundment for recycling cooling water used in the vulcanization of rubber hose. The bottom sediments had become contaminated with metals and volatile organic compounds. A groundwater monitoring network was installed to measure any impact of the unit on the surficial aquifer. A feasibility study investigated several remedial alternatives.

A Surface Impoundment Closure Plan was prepared. The alternative chosen for this site included the design and construction of a new industrial wastewater treatment plant which would be used to treat all of the water in the surface impoundment and would serve to treat recycled water following elimination of the impoundment. Following removal of the water from the pond, the contaminated bottom sediments were removed and transported to a secure RCRA landfill. A total of about 4,000 tons of sediment were removed. The area occupied by the impoundment was capped with a native clay material.

Boston Industrial Products - Hohenwald, Tennessee - Landfill

The Company generates a significant quantity of waste hose from the quality control section. The hose historically has been placed in an on-site industrial landfill. The original landfill at the site was started in the late 1960's and used until 1980. That landfill was closed after about 30,000 cubic yards of waste had been buried. At that time, a new landfill was designed by W. Z. Baumgartner & Associates, Inc. and permitted by the Tennessee Division of Solid Waste Management. The landfill has been expanded three times since the initial permit.

W. Z. Baumgartner & Associates, Inc. assisted the Company in evaluating a private resource recovery facility for incinerating the hose and producing steam for the plant vulcanizers. Such a facility is now in operation and burns about 85% of the waste hose.

In 1989 the old, unpermitted landfill experienced a structural failure. A portion of the cover on a steep outslope was eroded during a heavy rainfall and the waste began to slide downhill. W. Z. Baumgartner & Associates, Inc. designed a replacement cell for the material and a new slope design for the old fill. W. Z. Baumgartner & Associates, Inc. was able to get a fast track approval (within 30 days) for this corrective action from the Division of Solid Waste Management.

Fullen Dock Industrial Landfill - Memphis, Tennessee

This facility is a private landfill designed to serve two recycling companies and a bulk materials dock facility. The landfill consists of three (3) cells (one initial and two future) with a total area of 80 acres.

This landfill has several unusual features. First, the entire area of the landfill was originally in the 100 year flood plain of the Mississippi River. A levee system was constructed around the landfill site under a Corps of Engineers Permit. The finished grade of the landfill would be found (4) feet above 100 year flood elevation.

Second, dredged river sand from Mississippi River channel maintenance is used for a stability layer over waste. The waste (automobile shredder residue) is non-putrescible and the sand was placed in a four (4) foot thick layer over the waste to accelerate compaction and

to prevent differential settlement. Completed cells will be used for bulk material storage and warehouse construction for port facility.

Third, permission was obtained from SWM for a demonstration project using sludge from the City of Memphis WWT as a soil builder in the final cover.

Roane Alloys Site - Rockwood, Tennessee - Superfund

W. Z. Baumgartner & Associates, Inc. was retained to prepare the site investigation plan after the site was listed on the Tennessee State Superfund List. Following approval of the plan by DSF, W. Z. Baumgartner & Associates, Inc. was responsible for all environmental sampling and data interpretation on the 300 acre site. Several piles of waste materials (slag and emission control residues) were identified as potential sources of contamination (primary contaminants were lead, arsenic and chromium). The groundwater investigation involved the installation of five (5) shallow wells and seven (7) deep wells to evaluate the impact of several different waste storage areas on the groundwater.

A Remedial Investigation/Feasibility Study (RI/FS) for the site was prepared by W. Z. Baumgartner & Associates, Inc. for the Technical Committee of the PRP's. Following acceptance by the Technical Committee, the RI/FS was submitted to DSF. Several minor revisions were made at the request of DSF and a Record of Decision was negotiated.

The Technical Committee engaged W. Z. Baumgartner & Associates, Inc. to management the site remediation. A total of five (5) contracts were let to three (3) different contractors. W. Z. Baumgartner & Associates, Inc. provided on-site management as well as overall project control. Total remediation costs were held to just under \$3 million (35% less than estimated by a national remediation contractor).

W. Z. Baumgartner & Associates, Inc. is currently providing the post-remediation site monitoring and care as well as managing the demolition of all site buildings and facilities.

Auto Shred Industries Industrial Landfill - Pensacola, Florida - State DER

The Company had operated a private shredder residue landfill for 15 years. The landfill had been permitted by the County Solid Waste Authority. Changes in the State Solid Waste Regulations required that this landfill be closed.

Initial environmental evaluations had to be performed before the landfill could be closed. The primary aspect of this evaluation was the groundwater monitoring. The groundwater monitoring was particularly critical because the landfill was located in a groundwater recharge area upstream from a critical estuary habitat.

The monitoring network involved the installation and monitoring of eight (8) wells and two (2) surface seep areas. Monitoring had to be performed in accordance with the Florida Department of Environmental Regulation QA/QC protocol.

After the initial environmental evaluations demonstrated that the landfill was not having an adverse impact on the environment, a detailed closure plan was prepared. Following approval of the Closure Plan, W. Z. Baumgartner & Associates, Inc. prepared detailed construction plans and assisted the owner in negotiating the closure services.

Yorke Doliner Company Industrial Landfill Closure - Rockledge, Florida

The Company had operated a private, on-site landfill for shredder residue for about 20 years. Changes in the State Solid Waste Regulations required that this landfill be closed. Prior to the actual closure design the company was required by DER to document the landfill was not having an impact on the groundwater. The groundwater characterization and assessment was complicated by the fact that both a shallow and a deep aquifer had to be monitored.

During the period while the groundwater assessment was being conducted, W. Z. Baumgartner & Associates, Inc. assisted the company in evaluating the feasibility of mining the landfill and recovering additional metals using eddy-current technology. A presentation was made to the Florida Division of Solid Waste concerning the mining possibility. The Division has given approval to the concept and a detailed Closure/Reprocessing Plan is being prepared.

W Z B

Harper Cave Site/Dante Site - Knox County, Tennessee - Superfund

Both sites had been used for the disposal of tailings from a mining operation. The Tennessee Division of Superfund had made a preliminary evaluation and ranking of the sites. Under the state ranking criteria, both sites scored high enough to be placed on the state site list.

W. Z. Baumgartner & Associates, Inc. assisted the owner in negotiating with the DSF and in preparing a Site Investigation Plan. All environmental sampling was performed by W. Z. Baumgartner & Associates, Inc.. Data evaluation was conducted by W. Z. Baumgartner & Associates, Inc. and an assessment submitted to the corporate engineering staff of the PRP's. W. Z. Baumgartner & Associates, Inc. consulted with the PRP's relative to the drafting of the feasibility study prepared by the corporate engineering staff.

Industrial Metals Site - Corpus Christi, Texas - Superfund

The Industrial Metals Site was formerly occupied by a scrap recycling facility. During the operating history, the facility processed automotive batteries and electrical transformers. The acid from the batteries was poured into auger holes around the property. Oil from the electrical transformers (some containing PCB) was used for weed control on the property.

The State of Texas identified the PCB contamination and directed a Phase I remediation of site for the PCB contaminated soils. Subsequently, the state notified all lead shippers that they were considered PRP's for the site. The lead shippers were assessed for the Phase I remediation work and notified that they would be responsible for Phase II remediation plus post remediation care of the site.

A group of the shipper PRP's retained W. Z. Baumgartner & Associates, Inc. to evaluate the reasonableness of the assessment for Phase I costs, particularly those costs associated with characterization and management of the site. Preliminary findings submitted by W. Z. Baumgartner & Associates, Inc. indicate that the lead shippers were being assessed an unreasonably high percentage of the Phase I costs. The project is presently on-hold pending a judgement in Federal Court relative to State versus Federal jurisdiction.

SITE ASSESSMENT PROJECTS

Petro Stopping Centers - Nationwide

In order to secure a \$63,990,000 financing arrangement, Petro, Inc. contracted W. Z. Baumgartner & Associates, Inc. to perform Environmental Audits of numerous facilities across the U.S. The Engineers completed the work on time and for the contract price to the complete satisfaction of Petro, Inc. and Chemical Bank Investment.

Petro Stopping Centers - Nationwide

Comprehensive Site Assessment and Environmental Audit of 20 Petro facilities was completed by W. Z. Baumgartner & Associates, Inc. in 1990. The work was performed using criteria provided by Chapman & Cutler and was completed within 30 days of receiving authorization to initiate the project. The audit included sites in Alabama, Arizona, California, Louisiana, New Jersey, New Mexico, Ohio, Oklahoma, Tennessee and Texas.

Colorado Fuel & Iron Site - Colorado, Kansas, New Mexico

W. Z. Baumgartner & Associates, Inc. conducted Environmental Site Assessments at each of the three (3) shredding facilities owned and operated by CF&I Steel Corporation. These facilities were located in Albuquerque, New Mexico, Denver, Colorado and Wichita, Kansas. The Assessments were conducted on behalf of CF&I Steel Corporation as directed by and to the satisfaction of the U.S. Bankruptcy Court. At two of the properties, offsite and/or subsurface conditions which may impact the subject site were identified. Each of the facilities have been purchased and are operational at this time.

Confidential Client - Utah

The Engineers provided Phase I/Phase II investigations of three (3) scrap recycling facilities in Northern Utah. The investigations were performed during negotiations for purchase of properties. Site characterization included surficial soil sampling in selected areas, as well as subsurface investigation utilizing auger drill rigs to obtain soil samples from various

depths in the vadose and saturated zones. Groundwater monitoring wells were constructed in selected boring locations. The field work/engineering phase of the project was completed on-time and under budget. The results of the investigation were used in the final negotiations for property transfer.

Confidential Client - Colorado

The Engineers conducted a site investigation of a former foundry and iron works located in the Denver, Colorado area. This site was originally developed as a brickyard at the turn of the century, and subsequently as a foundry, complete with a plate shop, forge shop, machine shop, pattern shop, maintenance building, warehouses and material storage yard. The 18 acre site contained slurry basins, quenching oil basins, aboveground and underground petroleum storage tanks, transformer stations and a paint shop. At each of these locations there was reason to suspect the release, either by design or accident, of materials which may have negatively impacted the property. The investigation was tailored to meet the site-specific requirements, and considerable data was generated through the surface and subsurface sample analysis, as well as an extensive historical records review.

Confidential Client - North Carolina

Following removal of a 15,000 gallon underground storage tank containing diesel fuel, an independent contractor to the North Carolina Department of Environmental Management discovered petroleum fuel hydrocarbons in the vicinity of the tank excavation at concentrations in excess of UST Program Action levels. At the request of the Owner, W. Z. Baumgartner & Associates, Inc. conducted an initial Site Investigation and subsequent Comprehensive Site Assessment to ascertain the contaminant source and extent of contamination. A petroleum plume was delineated during the Assessment, remedial alternatives were developed and evaluated as part of the Corrective Action Plan and a Soil Vapor Extraction Air Sparging system is currently in operation. The contaminant plume is being remediated in accordance with NCDDEM requirements and recent sampling events indicate the absence of free floating and dissolved phase contaminants in each of the monitoring wells sampled.

Confidential Client - Washington, D.C.

A former vacant tract of land was leased for use as an automobile parts yard. At the end of the lease term, the lessor and lessee were unable to agree on terms for a subsequent lease and the lessee chose to move their operations. The lessor demanded the tenant "remediate" the site and return it to its original. Considerable disagreement as to the original condition followed. While the Owner maintained the site had been free of possible contamination, the tenant believed otherwise, based on personal accounts of previous industrial activity on the property. Through investigation of historical aerial photographs, the Engineers were able to establish prior industrial use and through environmental sampling confirmed the location of various equipment based on chemical constituents found in samples analyzed. Ground Penetrating Radar (GPR) was also utilized in subsurface survey of selected portions of the yard. The investigation established prior use and impact not reasonably attributable to the lessee.

(Confidential Client)

W. Z. Baumgartner & Associates, Inc. is presently assisting a client in complying with a regulatory order concerning possible contamination on a 10 acre abandoned scrap yard. The preliminary surface soil samples indicate contamination with metals, petroleum hydrocarbons and PCB's. Initial groundwater data was inconclusive relative to the impact of the site.

W. Z. Baumgartner & Associates, Inc. has been successful in negotiating a preliminary agreement with the regulatory agency allowing a "close-in-place" option provided on-going risk assessments show the site is not having a major impact on human health or the environment.

(Confidential Client)

A metals recycling facility which operates a shredder accumulated approximately 50,000 tons of shredder residue on-site in an unpermitted storage area. The state regulatory agency required the company to dispose of the material as a hazardous waste based on samples collected by the state.

W. Z. Baumgartner & Associates, Inc. was retained by the company and determined that the state's characterization may not be representative of the entire pile. A more comprehensive sampling plan was developed based on W. Z. Baumgartner & Associates, Inc.'s published protocol for this waste material. Following approval of the plan by the state, W. Z. Baumgartner & Associates, Inc. conducted an extensive waste characterization. Based on the new waste characterization, W. Z. Baumgartner & Associates, Inc. recommended to the state that the material be approved for disposal in a Subtitle D landfill. The recommendation was approved and arrangements are underway for removing the waste. A site closure study will be required after all of the waste has been removed.

(Confidential Client)

A metals recycling facility operated an on-site landfill for shredder residue of 20 years when the state solid waste regulations were changed to require formal closure of such facilities. The closure regulations required groundwater monitoring prior to closure. The samples from some of the wells adjacent to the landfill had elevated levels of some metals and organics. The state notified the company that the entire landfill must be moved.

W. Z. Baumgartner & Associates, Inc. was retained by the company and was successful in demonstrating that at least some of the elevated levels were not related to the landfill but to other industrial activity in the area. Further, W. Z. Baumgartner & Associates, Inc. was successful in obtaining approval from the state to re-mine the landfill to recover additional metals using eddy-current technology. The state has agreed to an extended closure schedule to allow the processing of the material.

APPENDIX B

W Z B



Midwest Metallics L.P.

93/00
C

Mr. Gino Bruni
Illinois Environmental Protection Agency
Division of Land Pollution Control
1701 South 1st Avenue
Maywood, Illinois 60153

RE: Pond Water Sampling Results

Dear Gino:

I'm sending you the results from the analysis of the water and sediment samples which the IEPA and Baumgartner & Associates collected last March 17th from the retention pond at our Summit facility. The results obtained by Baumgartner indicate that neither the water nor the sediment is hazardous.

When the IEPA has completed its analysis, I would appreciate you letting me know the results. Hopefully the IEPA's results will be consistent with the Baumgartner analysis.

Please give me a call if you have any questions.

Sincerely,

Terence J. Coogan

cc: William Z. Baumgartner

TJC/rs
Enclosure

EXHIBIT NO. 1

MIDWEST METALLICS, L.P.
SUMMIT, ILLINOIS

RECIRCULATION POND CHARACTERIZATION
COMPOSITE WATER SAMPLE ANALYSIS

MARCH 17, 1994

PARAMETER	CONCENTRATION	
TCLP METALS(mg/l)	RP-CW (32516)	EPA LIMIT
Arsenic	<0.10	5.0
Barium	<1.00	100.0
Cadmium	<0.10	1.0
Chromium	<0.50	5.0
Lead	2.54	5.0
Mercury	<0.010	0.2
Selenium	<0.10	1.0
Silver	<0.10	5.0
Constituent PCB(mg/kg)	<0.10	50
pH	7.4	---
Temperature	10°C	---

W. Z. BAUMGARTNER & ASSOCIATES, INC.
Consulting Engineers
P. O. Box 786
Brentwood, TN 37024-0786

EXHIBIT NO. 2

MIDWEST METALLICS, L.P.
SUMMIT, ILLINOIS

RECIRCULATION POND CHARACTERIZATION TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP)

WATER SAMPLE ANALYSIS

MARCH 17, 1994

PARAMETER	CONCENTRATION					EPA LIMIT
	RP-1W (32512)	RP-3W (32513)	RP-6W (32514)	RP-7W (32515)	TRIP BLANK (32517)	FIELD BLANK (32518)
TCLP VOLATILES(mg/l)						
Benzene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Carbon tetrachloride	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chlorobenzene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chloroform	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,2-Dichloroethane	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,1-Dichloroethene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Methylethylketone	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Tetrachloroethene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Trichloroethene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Vinyl Chloride	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

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EXHIBIT NO. 2 (Continued)

MIDWEST METALLICS, L.P.
SUMMIT, ILLINOISRECIRCULATION POND CHARACTERIZATION
TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP)
WATER SAMPLE ANALYSIS

MARCH 17, 1994

PARAMETER	RP-1W (32512)	RP-3W (32513)	RP-6W (32514)	CONCENTRATION RP-7W (32515)	TRIP BLANK (32517)	FIELD BLANK (32518)	EPA LIMIT
TCLP SEMI-VOLATILES(mg/l)							
Cresols	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	200.0
1,4-Dichlorobenzene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	7.5
2,4-Dinitrotoluene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.13
Hexachlorobenzene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.13
Hexachloro-1,3-butadiene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.5
Hexachloroethane	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	3.0
Nitrobenzene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	2.0
Pentachlorophenol	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	100.0
Pyridine	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	5.0
2,4,5-Trichlorophenol	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	400.0
2,4,6-Trichlorophenol	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	2.0

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EXHIBIT NO. 3

MIDWEST METALLICS, L.P.
SUMMIT, ILLINOIS

RECIRCULATION POND CHARACTERIZATION COMPOSITE SLUDGE SAMPLE ANALYSIS

MARCH 17, 1994

PARAMETER	CONCENTRATION	
	RP-CS	EPA LIMIT
CONSTITUENT TCLP METALS(mg/kg) (32551)		
Arsenic	3.1	N.S.
Barium	216.	N.S.
Cadmium	19.1	N.S.
Chromium	23.0	N.S.
Lead	1960	N.S.
Mercury	2.37	N.S.
Selenium	< 1.0	N.S.
Silver	< 1.0	N.S.
TCLP METALS(mg/l) (32598)		
Arsenic	< 0.10	5.0
Barium	1.26	100.0
Cadmium	< 0.10	1.0
Chromium	< 0.50	5.0
Lead	< 0.50	5.0
Mercury	< 0.010	0.2
Selenium	< 0.10	1.0
Silver	< 0.10	5.0
(32551)		
PCB ¹ (mg/kg)	< 4.98	50
% Moisture	87.7	N.S.

¹Reported as "Dry Weight" - EPA Method 8080
N.S. - No Standard

W. Z. BAUMGARTNER & ASSOCIATES, INC.
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EXHIBIT NO. 4

MIDWEST METALLICS, L.P.
SUMMIT, ILLINOIS

RECIRCULATION POND CHARACTERIZATION TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP)

SEDIMENT SAMPLE ANALYSIS

MARCH 17, 1994

PARAMETER

CONCENTRATION

RP-1S
(32599)

RP-3S
(32600)

RP-6S
(32601)

RP-7S
(32602)

EPA
LIMIT

TCLP VOLATILES(mg/l)

Benzene

<0.1

<0.1

<0.1

<0.1

0.5

Carbon tetrachloride

<0.1

<0.1

<0.1

<0.1

0.5

Chlorobenzene

<0.1

<0.1

<0.1

<0.1

100.0

Chloroform

<0.1

<0.1

<0.1

<0.1

6.0

1,2-Dichloroethane

<0.1

<0.1

<0.1

<0.1

0.5

1,1-Dichloroethene

<0.1

<0.1

<0.1

<0.1

0.7

Methylethylketone

<1.0

<1.0

<1.0

<1.0

200.0

Tetrachloroethene

<0.1

<0.1

<0.1

<0.1

0.7

Trichloroethene

<0.1

<0.1

<0.1

<0.1

0.5

Vinyl Chloride

<0.1

<0.1

<0.1

<0.1

0.2

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EXHIBIT NO. 4 (Continued)

MIDWEST METALLICS, L.P.
SUMMIT, ILLINOISRECIRCULATION POND CHARACTERIZATION
TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP)
SEDIMENT SAMPLE ANALYSIS

MARCH 17, 1994

PARAMETER	RP-1S (32599)	RP-3S (32600)	CONCENTRATION RP-6S (32601)	RP-7S (32602)	EPA LIMIT
TCLP SEMI-VOLATILES(mg/l)					
Cresols	<0.1	<0.1	<0.1	<0.1	200.0
1,4-Dichlorobenzene	<0.1	<0.1	<0.1	<0.1	7.5
2,4-Dinitrotoluene	<0.1	<0.1	<0.1	<0.1	0.13
Hexachlorobenzene	<0.1	<0.1	<0.1	<0.1	0.13
Hexachloro-1,3-butadiene	<0.1	<0.1	<0.1	<0.1	0.5
Hexachloroethane	<0.1	<0.1	<0.1	<0.1	3.0
Nitrobenzene	<0.1	<0.1	<0.1	<0.1	2.0
Pentachlorophenol	<0.1	<0.1	<0.1	<0.1	100.0
Pyridine	<0.1	<0.1	<0.1	<0.1	5.0
2,4,5-Trichlorophenol	<0.1	<0.1	<0.1	<0.1	400.0
2,4,6-Trichlorophenol	<0.1	<0.1	<0.1	<0.1	2.0

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EXHIBIT NO. 5

MIDWEST METALLICS, L.P.
SUMMIT, ILLINOIS

RECIRCULATION POND CHARACTERIZATION
SPIKE MATRIX

MARCH 17, 1994

PARAMETER	% RECOVERY
TCLP METALS	RP-CS (32598)
Arsenic	101%
Barium	88%
Cadmium	86%
Chromium	87%
Lead	88%
Mercury	112%
Selenium	111%
Silver	82%

Note: Spike Matrix Recovery data for TCLP Volatile & Semi-Volatile organic determinations performed on individual samples available upon request.

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CHAIN OF CUSTODY

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APPENDIX C

W Z B

**PROTOCOLS FOR
SAMPLING, ANALYSIS AND DATA REVIEW
OF METAL SHREDDER WASTE**

**W. Z. BAUMGARTNER & ASSOCIATES, INC.
Environmental Consultants
Brentwood, Tennessee
615-373-1572**

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**PROTOCOLS FOR
SAMPLING, ANALYSIS AND DATA REVIEW
OF METAL SHREDDER WASTE**

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**PROTOCOLS FOR
SAMPLING, ANALYSIS AND DATA REVIEW
OF METAL SHREDDER WASTE**

A. PURPOSE OF SAMPLING PROTOCOL

Metal shredder waste is produced by the shredding of automobiles and light scrap iron and is inherently non-homogeneous in nature. Because of the nature of this waste material and a national lack of understanding of its properties, improper characterization has often been a common problem.

This sampling protocol has been developed by W. Z. Baumgartner & Associates, Inc. The basic protocol has been adopted by several state and federal regulatory agencies and is recognized by most of the major solid waste management firms. This document is the property of W. Z. Baumgartner & Associates, Inc. and is copyrighted. It is not to be reproduced in whole or in part without the written authorization of W. Z. Baumgartner & Associates, Inc. Excerpts can be utilized in reviews or for the Company's clients providing the original source is quoted.

B. GENERAL SAMPLING PROCEDURE

During sampling events, appropriate health and safety equipment should be worn. Minimum personal safety equipment should include steel-toed boots, sturdy gloves, hardhat, and safety glasses. A fully stocked first-aid kit should be on-site and readily available.

All samples are to be collected by an independent, qualified technician experienced with the unique shredding process and the characteristics of shredder residue.

When sampling contemporaneously generated metal shredder waste, normal plant operation should be confirmed with management prior to initiation of sample collection to ensure all equipment is in working order, and the infeed material is representative of the facility's normal operation.

Heavy duty, one (1) gallon, "ziplock" plastic freezer bags may normally be used for individual shredder residue sample collection. Five (5) to six (6) gallon buckets may be used for larger composite samples. It is understood that while there may be a slight possibility of minute level intrusion of phthalates into a sample from the plastic containers, the high concentration of phthalates in the shredder waste negates any concern. Detailed decontamination of heavy equipment is not normally necessary because of the volume of material being handled and the fact that the material is mixed by the same equipment during normal daily operation. Any individual sampling equipment, such as shovels, etc., should be wiped with clean paper towels or washed (as appropriate) after each use.

If complete QA/QC documentation is to be supplied or if special samples or sample containers (ie: glass with teflon lids for PCB or volatile organics analysis) are required, these requests are to be made to W. Z. Baumgartner & Associates, Inc. at least one (1) week before the proposed sample event. All sample preservation, temperature and holding time provisions of EPA *SW 846 (latest edition)* shall be observed.

C. CONTEMPORANEOUS GENERATION SAMPLING PROCEDURES

Contemporaneous sampling as the waste is being generated is the most representative type of sampling. This method is preferable to the waste pile sampling and should be used unless there are compelling reasons for using a different method.

During routine monitoring events sturdy five to six gallon plastic containers may be used for sample storage and shipping. The containers should have sealing, one-piece lids that cannot be opened without obvious damage to the integrity of the lid. During the routine sampling events, normal shredding operation should be maintained. Sampling will continue over a period of approximately one hundred twenty (120) minutes. Because of the high volume of the material generated this period has been demonstrated to be adequate to produce representative samples. Waste generated in the shredding process is sampled every ten (10) to twelve (12) minutes, generating ten (10) discrete samples. About two thousand (2,000) grams is collected for each sample.

The sample material is to be carefully selected so that it includes both large and small particles in approximate proportion of generation. The sampler is to be familiar with the process generating the waste, the composition of shredder residue in general, and shall be able, by experience, to avoid weighting the sample inappropriately by particle size, density, or constituency.

The collection of the samples is best done by hand. The sampler shall wear sturdy gloves for protection against any broken glass and scrap metal that may be encountered. Disposable overgloves, which are changed between each sample, should be worn.

D. WASTE PILE SAMPLING PROCEDURES

In the event that contemporaneous sampling is not possible, the following alternative procedure may be used.

Characterization of shredder waste piles presents certain challenges to the sampling team. The procedures presented in this Protocol are consistent with Environmental Protection Agency *Samples and Sampling Procedures for Hazardous Waste Streams (600/2-80-018)* and *Test Methods for Evaluating Solid Waste (SW 846 - 9/86)*. Sampling points are selected after a visual inspection of the pile. A blade-equipped front-end loader, backhoe, dozer or similar should be made available to the sampling team so that the pile can be properly configured for sampling.

For waste pile sampling, a pile of shredder waste equal to at least one-half (1/2) day of normal shredding operation should be accumulated. The pile should be configured by squaring the edges and top. Waste piles can be characterized by selecting three (3) evenly distributed sampling points as shown in Figure No. 1. For larger piles (greater than 100 ft. by 100 ft.) the number of sampling points should be increased to four (4) or five (5). Surface sampling points are selected and diagonals established that terminate at the base of the pile opposite the surface point. Collection of center-of-pile samples is facilitated by opening one (1) or more trenches selected so the diagonal middle sampling points pass through each trench.

Figure No. 1 presents a typical waste pile characterized by establishing three (3) diagonal sample lines and one trench. Samples are collected from the top of the pile at major surface points A-1, B-1, and C-1. Approximately two thousand (2,000) grams of representative material is collected at point A-1, B-1, and C-1. Using the

blade loader or backhoe, an opening is made at the base of the pile at diagonal points A-3, B-3, and C-3. These openings will be approximately three (3) to five (5) feet high and penetrate one (1) to three (3) feet into the pile. To facilitate midpoint sampling, an opening is made midway through the shorter cross-section of the pile. The opening should penetrate approximately one-half to two-thirds through the pile. Samples A-2, B-2, and C-2 are collected at the appropriate midway points on both walls diagonally from the initiation points. Sampling Points D-1, D-2, and D-3 are selected at the discretion of the sampling team.

Sampling should be performed so each sample location is representative of that general area of the pile. Samples are collected by "picking" many small aliquots from each selected sample point on the pile and combining these individual aliquots into the specific location sample. Each sample should contain approximately two thousand (2,000) grams of material. "Picking" can be performed by hand provided the outer gloves are changed between each sample location. If a shovel or other utensil is used to gain access to a location, the tool is to be cleaned between each location.

This sample protocol should generate a minimum of twelve (12) discrete samples available for analysis from a normal pile. For larger piles (greater than 100 ft. by 100 ft.) additional discrete samples should be generated. As previously stated, all aspects of the sample collection, processing, preservation and analysis shall be conducted in accordance with *SW 846 (latest edition)*.

E. SAMPLE CONTAINERS AND CHAIN-OF-CUSTODY PROCEDURES

As mentioned in Section A, heavy duty plastic bags normally may be used for individual samples and, if so used, are to be placed in a larger plastic bucket for secure transport. Each individual sample container is to be labeled as follows:

Sample Location:

Identifying Sample Code and Description:

Time:

Date:

Sampler:

The individual samples are to be carefully packaged in the shipping container. The container is to be sealed for transport to the laboratory. Larger composite samples may be collected using the six (6) gallon containers. If required, samples may be shipped in rigid, high-impact plastic ice chests. When using commercial carriers, dry ice is not to be used to cool samples. Crushed or cubed ice in plastic bags is preferable for this purpose.

The procedure for sample security and Chain-of-Custody documentation shall follow Environmental Protection Agency document *SW 846 (latest edition)* as a minimum. Each sample container is to be marked, coded, and sealed.

F. SAMPLE PROCESSING AND ANALYSIS

Shredder waste normally consists of 55-60%, by weight, of material less than two inches in diameter, while material larger than two inches in diameter may make up 55-60% of the uncompressed volume. Great care, based upon experience, must be employed to avoid weighting individual aliquots inappropriately by weight, volume, or size and to insure that aliquots are representative of the material generated.

1. Once the samples are received in the laboratory, a clean work area is selected and the samples processed. Each sample is first mixed and then spread out to a uniform depth. The sample is then divided into four (4) equal quarters and a subsample of one (100) to two (200) hundred grams is taken from each of the four (4) quarters. This subsample is then passed through a 9.5 mm screen. All material retained on the 9.5 mm screen is hand cut until all of the subsample has passed through the screen. Both the material retained on the screen and that passing are then recombined and quartered. Ten (10) to fifteen (15) grams are taken from each quarter to make up individual aliquots for PCB analysis. Samples for PCB analysis should contain approximately thirty-five (35) to fifty (50) grams of material.

Twenty-five (25) grams of material is then taken from each of the four (4) quarters to make up the sample for the TCLP extraction for cadmium and lead. A five (5) gram aliquot of the subsample is prepared for determination of extraction fluid (No. 1 or No. 2) following EPA Method 1311.

2. PCB determinations are to be performed only by technicians familiar with shredder waste and experienced in determinations performed on samples containing multiple interferences. Analyses shall be performed according to EPA Method 8080, with Method 3550 for extraction, solid sonification, and electron capture. External standardization shall be employed. The moisture content of one aliquot shall be measured.
3. A 100 gram aliquot (taken from the material processed in Section F-1) is to be used for Method 1311 "Toxicity Characteristic Leaching Procedures (TCLP)" as described in *40 CFR 261, Appendix 2* and *EPA SW 846 (latest edition)* for extractable heavy metals and semi-volatile organics. If TCLP Method 1311 is to be performed on a sample, strict conformity to the methods and procedures described in *SW 846 (latest edition)* must be exercised. A separate log entry shall be prepared for each application of the procedure and this log shall be maintained by the laboratory. The log and all other necessary data required for proper completion of the analysis procedure shall be retained for a minimum of three (3) years.
4. Protocols for zero headspace extraction, ZHE, for extractable volatile organic compounds are to conform to EPA Method 1311.
5. The laboratory performing the wet chemistry analysis is to be EPA Drinking Water Program approved.

G. DATA REVIEW - CONTEMPORANEOUS GENERATION

The normal procedure for contemporaneous sampling is to analyze a progressive number of samples from a sampling event. The following procedures describe the most reasonable data evaluation for both TCLP extractable heavy metals analyses and PCB determinations:

1. Using the procedures described in Section C, ten discrete composite time related samples are collected.
2. Three of the ten samples are selected using a random number selection method. The random numbers are unknown to the sampler. The samples are returned to the laboratory. One of the three samples is processed and analyzed for all eight TCLP extractable heavy metals. The remaining two samples are analyzed for extractable cadmium and lead (since cadmium and lead are the only heavy metals routinely found in the extract, only one analysis is performed for the other metals unless they are detected at a higher than normal levels). All three samples are analyzed for PCB concentration.
3. If the result of the mean of all three of the analyses is below the E.P.A. T.C.L.P. extractable heavy metals limit and/or TSCA limit for PCB's (50 mg/kg), the waste shall be considered non-hazardous and non-toxic. The calculation shall be the simple arithmetic mean of the laboratory results. The single analysis for the remaining six heavy metals will be reported.

4. If any of the three samples exceeds the EPA limit for any constituent but the arithmetic mean of the results of the three analyses are below EPA limits, then the waste will be considered nonhazardous.

If any of the three samples exceeds the EPA limit for any constituent and the mean of the data set exceeds the EPA limit, the generator will be notified and an aliquot from the original sample(s) analyzed for confirmation. The mean of the original and confirmation results of the sample(s) is calculated and this combined mean used to recalculate the new data set mean of the three sample analyses. If the recalculated mean of the event is below EPA limit(s), the waste will be handled as nonhazardous. According to the EPA and SW 846, the exceedence by one sample in a population does not determine the characteristics of the waste.

5. If the confirmation mean determined by the method described in Item 4 above still exceeds the E.P.A. limit for any constituent, a second sampling event should be scheduled within 15 days of the receipt of results to confirm the unusual reading. If, using the methods in Item 4 above, the second sampling event indicates nonhazardous conditions, the original event exceedence may be considered an anomaly and the waste continued to be handled as nonhazardous.
6. Other methods of evaluating data may be considered. However, it is important to note that attempts to apply EPA's confidence level method contained in Chapter 9 of SW 846 have demonstrated that the method is inappropriate for shredder waste. There are two primary reasons for this. First, the non-homogeneous nature of the waste makes procedures designed

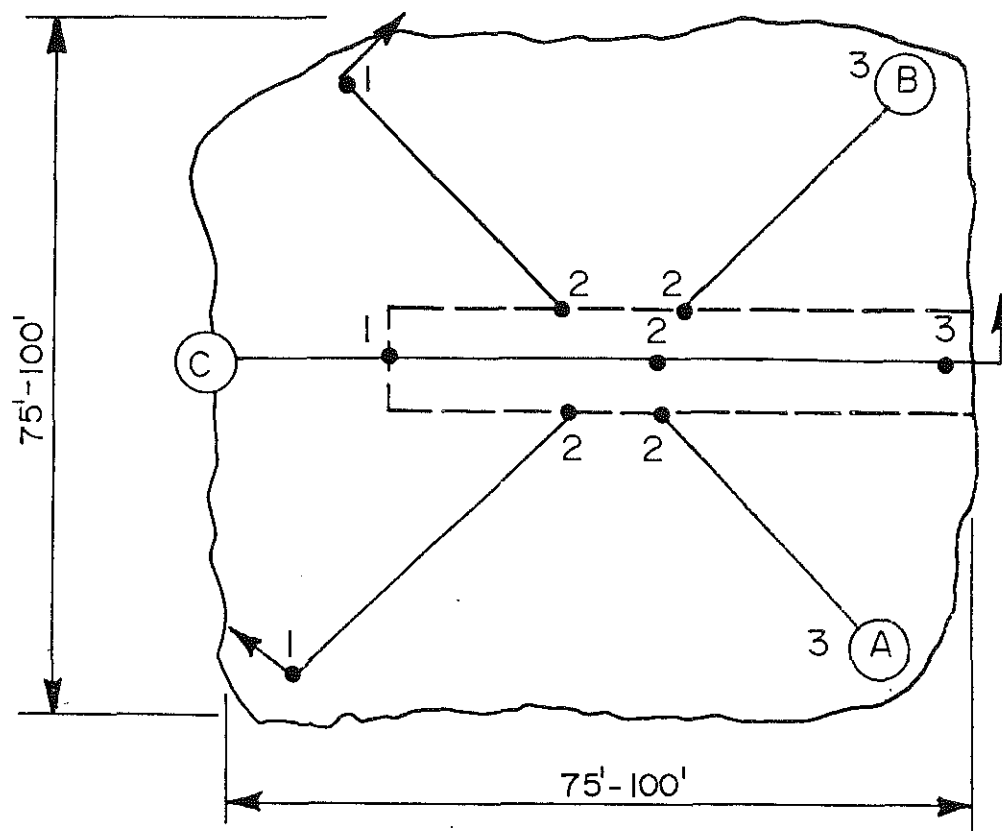
for soils and homogeneous waste questionable. Second, EPA has acknowledged that the method presented in the current edition of *SW 846* is mathematically flawed if the centrality of the data (i.e. the standard deviation is greater than the mean) is not easily defined. The primary method of statistical analysis shall be the simple arithmetic mean. Should one sample in the data set create an anomalous condition, the median may be used.

H. DATA REVIEW - WASTE PILE

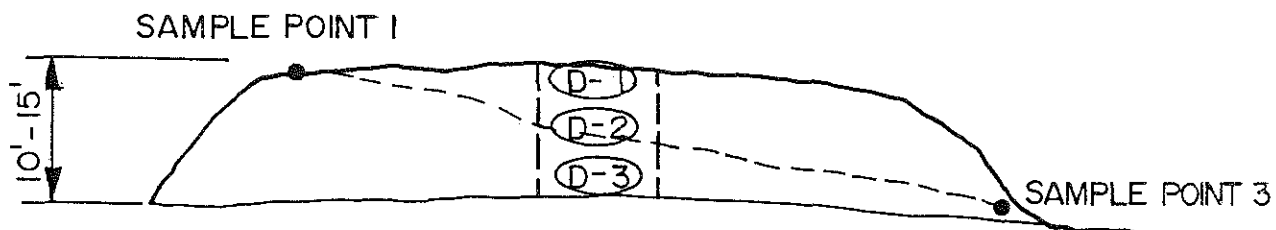
1. Using the methods described in Section B, a minimum of twelve (12) to twenty-five (25) samples are to be collected. Depending on the size of the pile(s), additional samples may be required.
2. Since this method may be used to characterize a pile for regulatory compliance, the number of samples to be analyzed shall be agreed upon in advance. If no such advance agreement is reached, ten (10) samples will be selected using random numbers.
3. The method for statistically evaluating the data shall be agreed upon in advance. Based on the variability of characteristics of shredder waste, W. Z. Baumgartner & Associates, Inc. has documented that the confidence interval method presented in Chapter 9 of *SW 846* is inappropriate for data generated from shredder waste monitoring events. The recommended method for evaluating the data should be the mean, or the median if the mean does not adequately define the center of the data.

FIGURE NO. 1

SHREDDER WASTEPILE TYPICAL SAMPLE POINT SELECTION



PLAN VIEW



CROSS- SECTION
TYPICAL FOR A,B,& C

FIELD SAMPLING PROCEDURES

W. Z. BAUMGARTNER & ASSOC., INC.

FRANKLIN, TENNESSEE

W. Z. BAUMGARTNER & ASSOCIATES, INC.

ENVIRONMENTAL CONSULTANTS

FIELD SAMPLING PROCEDURES
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1.0 INTRODUCTION

This document outlines the standard operating procedures (SOPs) and methods employed by W. Z. Baumgartner & Associates, Inc. to provide quality control of samples collected.

2.0 GENERAL

2.1 SAMPLE COLLECTION ORDER

Samples shall be collected from the suspected least to the most contaminated sampling locations within a site. Unless field conditions justify other sampling regimens, samples shall be collected in the following order:

- Volatile Organic Contaminants (VOCs)
- Extractable Organics [includes Total Recoverable Petroleum Hydrocarbons (TRPH), Oil & Grease, Pesticides and Herbicides]
- Total Metals
- Dissolved Metals
- Microbiological
- Inorganics (Includes Nutrients, Demands and Physical Properties)
- Radionuclides

2.2 USE OF PROTECTIVE GLOVES

Gloves serve a dual purpose: 1) protects the sample collector from potential exposure to sample constituents; and 2) minimizes accidental contamination of samples by the collector. Protective Gloves will be worn when conducting all sampling protocols, however, their use is not mandatory if:

- The sample source is considered to be non-hazardous; or
- The samples will not be analyzed for trace (i.e. part per billion level) constituents.

If worn, gloves should not come into contact with the sample, the interior of the container or lip of the sample container.

It is recommended that new, disposable, unpowdered latex gloves should be used. Gloves should be changed and discarded after every sampling point. Other types of gloves may be used as long as the construction materials do not contaminate the sample or if internal safety protocols require greater protection.

Note that certain materials (as might be potentially present in concentrated effluent) may pass through certain glove types and be absorbed in the skin. There are permeability tables for differing types of gloves that might be advisable in certain situations.

2.3 CONTAINER AND EQUIPMENT RINSING

When collecting aqueous samples the sample collection equipment and non-preserved containers shall be rinsed with sample water before the actual sample is taken.

This protocol shall not be followed for:

- Oil & Grease or TRPH - Neither the equipment (if used) nor the container shall be rinsed;
- Microbiological or VOCs - Sample containers shall not be rinsed; or
- Sample containers with premeasured preservatives in the container.

2.4 FUEL-POWERED EQUIPMENT

All fuel-powered equipment activities must be placed away from and downwind of any site activities (e.g. purging, sampling, decontamination). If field conditions preclude such placement, (i.e. the wind is from the upstream direction in a boat), the sampling activities shall be conducted as far away as possible from the fuel source(s) and the field notes must describe the conditions.

If possible, fuel handling (i.e. filling vehicles and equipment) should be done prior to the sampling day. If such activities must be performed during sampling, the personnel must wear disposable gloves. All fuel dispensing activities and glove disposal shall occur downwind and well away from the sampling activities.

2.5 PRESERVATION

All samples shall be preserved according to the requirements specified in Tables A-2 and A-3 found in appendix A. The holding times listed in the above-referenced tables supersede any that might be discussed in individual analytical methods. The holding times and preservation protocols specified by the tables listed above shall be followed. The preservation protocols in the referenced tables specify immediate preservation. EPA has defined "immediate" as "within 15 minutes of sample collection". This definition shall be followed for all sample preservation. Twenty-four hour composite water samples are the exception to the "15-minute" criteria.

3.0 DECONTAMINATION

3.1 GENERAL

All equipment shall be cleaned in a controlled environment and transported to the field pre-cleaned and ready to use. All equipment must be immediately rinsed with tap water after use, even if it is to be field cleaned for other sites. Equipment that is only used once (i.e. not cleaned in the field) must be tagged with the sample location, returned to the in-house cleaning facility and cleaned in a controlled environment.

3.2 REAGENTS

Detergents specified in this document refer to Liquinox (or equivalent) or Alconox (or equivalent).

3.2.1 Solvents

The solvent used in routine cleaning procedures shall be pesticide grade or nanograde isopropanol. Pesticide grade and nanograde are synonymous. Other solvents (i.e. acetone or methanol) may be used if they are pesticide grade. However, methanol is more toxic to the environment and acetone may be an analyte of interest for volatile organics. Acetone shall not be used if volatile organics are of interest. Precleaning heavily contaminated equipment may be done with reagent grade acetone and hexane.

3.2.2 Analyte-Free Water

Analyte-free water sources shall be subject to the following criteria:

- Analyte-free water is water in which all analytes of interest and all interferences are below method detection limits.
- This type of water shall be obtained from a reputable source and documentation

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shall be maintained to demonstrate reliability and purity of analyte-free water sources (i.e. results from equipment blanks). As a general rule, the following types of water should be used:

- a. Milli-Q (or equivalent) - suitable for all analyses
- b. Organic-free - may be suitable for only VOCs and extractable organics
- c. Deionized water - suitable for only inorganic analyses (metals, nutrients, etc.)
- d. Distilled water - suitable for inorganics or microbiology

Analyte-free water shall always be used for blank preparation and for the final in-house decontamination rinse. Analyte-free water shall be transported to the field in containers of suitable construction.

3.2.3 Protection of Cleaned Equipment

Decontaminated field equipment shall be protected from environmental contamination by securely wrapping and sealing with one of the following:

- Aluminum foil - grocery store type is acceptable;
- Untreated butcher paper; or
- Clean, disposable plastic bags may be used if only inorganics are of concern OR the equipment is first wrapped in foil or butcher paper.

3.2.4 Acids

All acids used for cleaning shall be reagent grade or better. Ten percent hydrochloric acid is prepared by mixing one part concentrated hydrochloric acid with 3 parts deionized water. Ten percent nitric acid is prepared by mixing one part concentrated nitric acid with 5 parts deionized water.

Prepare acid solutions by slowly adding the concentrated acid to water.

3.3 DECONTAMINATION/CLEANING PROTOCOLS - GENERAL CONSIDERATIONS

All sampling equipment (bailers, lanyards, split spoons, etc.) that come in contact with the sample must be cleaned/decontaminated before use. The procedures that are applicable to the majority of sampling equipment are listed in Section 3.4.1. Protocols for other specialized equipment are outlined in Sections 3.4.2 through 3.11.

If possible, sufficient clean equipment should be transported to the field so that an entire study can be conducted without the need for field cleaning. Unless otherwise justified, all field sampling equipment shall be precleaned in-house (office, lab, or base of field operations) prior to arrival on-site.

All cleaning shall be documented for each piece of field equipment. In-field decontamination shall be documented in the field records. These records shall specify the type of equipment that is cleaned and the specific protocols that are used. In-house cleaning records must identify the type of equipment (i.e. teflon bailers, PVC pump tubing, etc.), the date it was cleaned, the protocol or SOP that was used and the person who cleaned the equipment.

3.4 DECONTAMINATION/CLEANING PROTOCOLS - SAMPLING EQUIPMENT

3.4.1 General Cleaning Procedure for Teflon and Stainless Steel Sampling Equipment

This procedure shall be used when sampling for ALL parameter groups: extractable organics, metals, nutrients, etc.) or if a single decontamination protocol is

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desired to clean all Teflon and stainless steel equipment.

The cleaning procedures described below are for in-field cleaning. Information on in-house cleaning is documented in NOTE 1.

- a. Clean with tap water and lab grade soap (Liquinox or equivalent) using a brush, if necessary, to remove particulate matter or surface film (see NOTES 1, 2 and 3 of this section).
- b. Rinse thoroughly with tap water.
- c. If trace metals are to be sampled rinse with 10-15 % reagent grade nitric acid (HNO_3). The acid rinse should not be used on steel sampling equipment (bailers, augers, trowels, etc.). See NOTE 4.
- d. Rinse thoroughly with deionized water (DI). Enough water shall be used to ensure that all equipment surfaces are flushed with water.
- e. Rinse twice with isopropanol. One rinse may be used as long as all equipment surfaces are thoroughly wetted with free-flowing solvent.
- f. Rinse thoroughly with analyte-free water and allow to air dry as long as possible.
- g. Clean sampling equipment shall be wrapped (if appropriate) in aluminum foil, or in untreated butcher paper to prevent contamination during storage or transport to the field.
- h. If no further sampling is to be performed, equipment must be rinsed with tap water immediately after use.

NOTES:

1. In house Protocols require the following:
 - a. Protocols must include the use of HOT tap water and cleaning in a contaminant-free environment.

- b. Analyte-free water must be used as a final rinse.
- 2. Heavily contaminated equipment should not be cleaned in the field. Such rigorous cleaning procedures should be performed at the base of operations. Cleaning at the base of operations or in the field require the following:
 - a. Pre-rinse equipment using the following solvents in the order described: acetone-hexane-acetone. The solvent rinse(s) must precede the soap and water wash described in the first step (a. above).
 - b. In extreme cases, it may be necessary to steam clean the field equipment before proceeding with step a. above.
 - c. If the field equipment cannot be cleaned utilizing these procedures, it should be discarded, unless further cleaning with stronger solvents and/or oxidizing solutions are effective.
- 3. Liquinox (or equivalent) is recommended by EPA, although Alconox (or equivalent) may be substituted if nutrients are not sampled.
- 4. If sampling for nutrients, a 10-15% reagent grade hydrochloric acid (HCl) rinse should be used (except stainless steel equipment). If BOTH metals and nutrients are to be sampled, the HCl rinse must replace the HNO₃ rinse, or the HNO₃ rinse must be followed by the HCl rinse.
- 5. Hot detergent solutions and water rinses are not required for in-field decontamination.

3.4.2 Teflon and glass equipment used to collect aqueous and solid samples for trace organics and metals [including oil & grease, TRPH, and total organic halogens (TOX)].

In-house cleaning - follow 3.4.1, see NOTES 1 and 2.

In-field cleaning - follow 3.4.1, see NOTES 2 and 5.

3.4.3 Stainless Steel or Other Metallic Equipment used to collect Trace Organics and Metals (includes oil and grease, TRPH, TOX)

In-house cleaning - follow 3.4.1, see NOTES 1 and 2, delete acid rinse.

In-field cleaning - follow 3.4.1, see NOTES 2 and 5, delete acid rinse.

3.4.4 All Equipment Used to Collect ONLY Nutrients (NH₄, NO₃, etc.) and Inorganic Anions (Cl-, SO₄, F-, etc.)

In-house cleaning - follow 3.4.1 see NOTES 1, 3, and 4; delete solvent rinse.

In-field cleaning - equipment may be rinsed with analyte-free water immediately after use, then rinsed several times with sample water from the next sample.

3.4.5 All Equipment Used to Collect ONLY Demands and other inorganic non-metals

In-house cleaning - follow 3.4.1 see NOTE 1, delete solvent and acid rinses.

In-field cleaning - equipment may be rinsed with analyte-free water immediately after use, then rinsed several times with sample water from the next sample.

3.5 AUTOMATIC WASTEWATER SAMPLERS, SAMPLING TRAINS AND BOTTLES

3.5.1 General

All ISCO and other automatic samplers shall be cleaned as follows:

- a. The exterior and accessible interior (excluding the waterproof timing mechanisms) portions of automatic samplers shall be washed with

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laboratory detergent (see 3.4.1 NOTE 3 above) and rinsed with tap water.

- b. The face of the timing case mechanisms shall be cleaned with a clean, damp cloth.
- c. All tubing (sample intake and pump tubing) should be checked and changed on a regular basis. Tubing shall be changed if it has become discolored (i.e. mold and algae) or if it has lost its elasticity.
- d. New pre-cleaned Silastic pump tubing shall be installed.

3.5.2 ISCO (or equivalent) Automatic Sampler Rotary Funnel and Distributor

- a. Clean with hot water, laboratory detergent (see 3.4.1 NOTE 3 above) and a brush.
- b. Rinse thoroughly with deionized water.
- c. Replace in sampler.

3.5.3 All Automatic Sampler Headers

- a. Disassemble header and using a bottle brush, wash with hot water and phosphate-free laboratory detergent.
- b. Rinse thoroughly with deionized water.
- c. Reassemble header, let dry thoroughly and wrap with aluminum foil.

3.5.4 Reusable Glass Composite Sample Containers

- a. If containers are used to collect samples that contain oil, grease or other hard to remove materials, it may be necessary to rinse the container several times with reagent-grade acetone before the detergent wash. If material cannot be removed with acetone, the container must be discarded.
- b. Wash containers thoroughly with hot tap water and laboratory detergent

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(see 3.4.1 NOTE 3 above).

- c. Rinse containers thoroughly with hot tap water.
- d. If metals are to be samples, rinse containers with at least 10 percent nitric acid (see 3.4.1 NOTE 4 above).
- e. Rinse containers thoroughly with tap water.
- f. Rinse containers thoroughly with deionized water.
- g. If organics are to be sampled, rinse twice with solvent (isopropanol recommended) and allow to air dry for at least 24 hours.
- h. Cap with aluminum foil, Teflon film or the decontaminated teflon-lined lid.
- i. After using, rinse with tap water in the field, seal with aluminum foil to keep the interior of the container wet, and return to the laboratory or base of operations.
- j. Containers should not be recycled or reused if:
 - 1. Containers used to collect in-process (i.e. untreated or partially treated) wastewater samples at industrial facilities;
 - 2. Any bottle having a visible film, scale or discoloration that remains after the above protocols have been used; or
 - 3. Containers were used to collect samples at pesticide, herbicide or other chemical manufacturing facilities that produce toxic or noxious compounds. Such containers shall be properly disposed of (preferably at the facility) at the conclusion of the sampling activities.

If the containers described above are reused, no less than 10% of the cleaned containers must be checked for the analytes of interest BEFORE use. If found to be contaminated (i.e. constituents of interest are found at MDL levels or higher), the containers SHALL BE DISCARDED.

3.5.5 Plastic Reusable Composite Sample Containers

- a. Use the protocols outlined in decontamination for reusable glass composite containers (section 3.5.4) above but omit the solvent rinse.
- b. Restrictions on reused or recycled containers listed in 3.5.4j above shall be followed.

3.5.6 ISCO (or equivalent) Glass Sequential Sample Bottles for Automatic Sampler Based for Sequential Mode

Glass sequential sample bottles to be used in collecting inorganic samples shall be cleaned using the following protocol:

- a. Rinse with 10 percent nitric acid.
- b. Rinse thoroughly with tap water.
- c. Wash in dishwasher at wash cycle, using laboratory detergent cycle, followed by tap and deionized rinse cycles. Note: containers may be manually washed using protocol followed in "decontamination for reusable glass composite containers" (section 3.5.4) above. Solvent rinse should be deleted.
- d. Replace bottles in covered, automatic sampler base; cover with aluminum foil for storage.
- e. Rinse bottles in the field with tap water as soon as possible after sampling event.

3.6 FILTRATION EQUIPMENT

3.6.1 Dissolved Constituents using In-Line, Molded and Disposable Filter Units

- a. Peristaltic pump
 1. The peristaltic pump is cleaned per section 3.8.2b "Pumps used for sampling"

2. The silastic pump tubing is cleaned per section 3.7.2
 3. If Teflon tubing is used, it must be cleaned per 3.7.1
 4. Other tubing types [high density polyethylene (HDPE), etc.] must be cleaned according to the appropriate protocol listed in 3.7.
- b. Other equipment types (e.g. pressurized teflon bailer)
- Other types of equipment that utilize in-line, molded and disposable filters shall follow the appropriate cleaning regimen specified in Sections 3.4.1 through 3.4.6.

3.6.2 Dissolved Constituents using Non-disposable Filtration Units (i.e. syringes, "tripod assembly", etc.)

- a. Proceed with steps a through e of section 3.4.1, assembling and applying pressure to the apparatus after each rinse step (water and acid) to drive rinse material through the porous filter holder in the bottom of the apparatus.
- b. Remove and clean any transfer tubing per appropriate cleaning protocols (see section 3.7).
- c. Assemble the unit and cap both the pressure inlet and sample discharge lines (or whole unit if a syringe) with aluminum foil to prevent contamination during storage.
 1. Note: if the unit is to be used to filter only inorganic constituents (i.e. metals, nutrients, etc.), the unit may be sealed in a plastic bag to prevent contamination.

3.7 SAMPLE TUBING DECONTAMINATION

3.7.1 Teflon Tubing

3.7.1.1 New Tubing

If new tubing is used once and discarded, preclean as follows:

- a. rinse outside of tubing with pesticide-grade solvent
- b. flush inside of tubing with pesticide-grade solvent
- c. dry overnight in drying oven or equivalent (zero air, nitrogen, etc.)

3.7.1.2 Reused Tubing

Tubing shall be transported to the field in precut, precleaned sections. The description below was written for in-lab cleaning only, **FIELD CLEANING IS NOT RECOMMENDED**. In-house cleaning shall follow these steps:

- a. Exterior of the tubing must be cleaned first by soaking the Teflon tubing in hot, soapy water in a stainless steel sink (or equivalent non-contaminating material). Use a brush to remove any particulates, if necessary.
- b. Take a small bottle brush and clean the inside of the tubing ends where the barbs are to be inserted.
- c. Rinse tubing exterior and ends liberally with tap water.
- d. Rinse tubing surfaces and ends with nitric acid, tap water, isopropanol, and finally analyte-free water.
- e. Place tubing on fresh aluminum foil. Connect all of the pre-cut lengths of Teflon hose with Teflon inserts or barbs.
- f. Cleaning configuration:
 1. Cleaning reagents (soapy water, acid, isopropanol, etc.)

shall be placed in an appropriately cleaned container (2-liter glass jar is recommended)

2. Place one end of the teflon tubing into the cleaning solution.
3. Attach the other end of the teflon tubing set to the INFLUENT end of the peristaltic pump.
4. The effluent from the peristaltic pump may be recycled by connecting tubing from the effluent to the glass jar with the cleaning reagents.
5. Recycling as described above may be done for all reagents listed in g below **EXCEPT** the final isopropanol rinse and the final analyte-free water rinse. Disconnect the tubing between the effluent end of the pump and the jar of cleaning reagents.
 - a) Isopropanol should be containerized in a waste container for proper disposal;
 - b) Analyte-free water may be discarded down the drain.

g. Using the above configuration:

1. Pump copious amounts of hot, soapy water through the connected lengths.
2. Follow with tap water, 10% nitric acid, tap water, then isopropanol, and finally analyte-free water.
3. During the nitric acid and solvent rinses, turn the pump off and allow the reagents to remain in the tubing for 15 minutes, then continue with the next step. Pumping a liter (each) of the nitric acid and solvent should be sufficient, depending on the inside diameter of the hose.

4. Leave the Teflon inserts or barbs between the pre-cut lengths and cap or connect the remaining ends.
- h. After the interior has been cleaned as described above, the exterior shall be rinsed with analyte-free water.
- i. The connected lengths should then be wrapped in aluminum foil or untreated butcher paper and stored in a clean, dry area until use. Documentation for this cleaning shall be noted in the organization cleaning records.

3.7.2 Silastic Rubber Pump Tubing used in Automatic Samplers and other peristaltic pumps

This tubing need not be replaced if the sample does not contact the tubing or if the pump is used for only purging (i.e., not being used to collect samples). Tubing must be changed on a regular basis if used for sampling:

- a. Flush tubing with hot tap water and lab-grade detergent solution
- b. Rinse thoroughly with hot tap water
- c. Rinse thoroughly with DI water
- d. If used to collected metals samples, the tubing shall be flushed with 1+5 nitric acid, followed by thorough rinsing with DI water
- e. Install tubing in peristaltic pump or automatic WW sampler
- f. Cap both ends with aluminum foil or equivalent

NOTE: Tubing must be changed at specified frequencies as part the preventative maintenance on the equipment.

3.7.3 Miscellaneous Non-Inert Tubing Types (tygon, rubber, HDPE, PVC, etc.)

3.7.3.1 New Tubing

- a. As a general rule, new tubing may be used without preliminary

cleaning.

- b. New tubing shall be protected from potential environmental contamination by wrapping in aluminum foil, sealing in plastic bags or in the original sealed packaging.
- c. If new tubing is exposed to potential contamination, the exterior and interior shall be thoroughly rinsed with hot tap water followed by a thorough rinse with deionized water.
- d. If new tubing is to be used to collect samples, the tubing shall be thoroughly rinsed with sample water (i.e. pump sample water through the tubing) before collecting samples.

3.7.3.2 Reused Tubing

- a. Flush tubing with soapy solution of hot tap water and laboratory detergent.
- b. Rinse exterior and interior thoroughly with hot tap water.
- c. Rinse exterior and interior thoroughly with deionized water.
- d. If used to collect metals samples, the tubing shall be flushed with 10% nitric acid, followed by thorough rinsing with DI water
- e. Wrap tubing and cap ends in aluminum foil and seal in plastic to prevent contamination during storage and transport.

3.8 PUMPS

3.8.1 Submersible pumps

3.8.1.1 Pumps used for purging and sampling trace metals and/or organics

- a. Construction of pump body and internal mechanisms (bladders,

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impellers, etc.), including seals and connections must follow Table A-1 in Appendix A.

- b. Choice of tubing material must follow Table A-1 in Appendix A.

- c. Pump exterior must be cleaned per section 3.4.1.

Note: the solvent rinse shall be deleted if the pump body is constructed of plastic (i.e. ABS, PVC, etc.)

- d. Pump internal cavity and mechanism must be cleaned as follows:

1. If for purging only, then the pump must be completely flushed with potable water prior to purging the next well.
2. If for purging and sampling, then it must be completely disassembled (if so designed) and decontaminated between each well.
3. If the pump cannot be (practically) disassembled, then the internal cavity/mechanism must be cleaned by pumping copious amounts of lab-grade soap solution, tap water, and DI water.

- e. Teflon tubing will be cleaned per section 3.7.1.

- f. Cleaning of non-inert tubing shall follow the appropriate protocols in section 3.7 above (NOTE: very few options exist for non-inert tubing to be used for purging and/or sampling for trace organics).

3.8.1.2 Pumps used for all other constituents (nutrient/ inorganic anions)

- a. Pump construction - no restrictions
- b. Pump tubing material - no restrictions

- c. Scrub the exterior of the pump with appropriate metal-, phosphate- or ammonia-free detergent solution
- d. Rinse the exterior with tap water and deionized water
- e. Rinse interior of pump and tubing by pumping tap or deionized water through the system using clean bucket or drum.

3.8.2 Above Ground Pumps Used for Purging and Sampling

3.8.2.1 Pumps used for purging only

- a. Exterior of the pump must be free of oil and grease
- b. Tubing choice must follow restrictions as specified in Table A-1 in Appendix A.
- c. Tubing coming in contact with formation water shall be cleaned according to the appropriate protocol for construction materials specified in section 3.7.

3.8.2.2 Pumps used for sampling

- a. Exterior of pump must be cleaned with a detergent wash followed by tap and DI water rinses
- b. Tubing choice must follow restrictions as specified in Table A-1 in Appendix A.
- c. Tubing coming in contact with formation water shall be cleaned according to the appropriate protocol for construction materials specified in section 3.7.

3.9 FIELD INSTRUMENTS AND DRILLING EQUIPMENT

3.9.1 Field Instruments (tapes, meters, etc.)

- a. wipe down equipment body, probes, and cables with lab-grade detergent solution,
- b. rinse thoroughly with tap water,
- c. rinse thoroughly with DI water, and
- d. wrap equipment in aluminum foil, untreated butcher paper or plastic bags to eliminate potential environmental contamination.

An optional isopropanol rinse may be performed if equipment comes in contact with contaminated water, etc.

3.9.2 Soil Boring Equipment

This pertains only to equipment that is NOT used to collect samples. Split spoons, bucket augers and other sampling devices must be cleaned per requirements listed in 3.4.1 or 3.4.3 above.

- a. The engine and power head, auger stems, bits and other associated equipment should be cleaned with a power washer, steam jenny or hand washed with a brush using detergent (no degreasers) to remove oil, grease, and hydraulic fluid from the exterior of the unit.
- b. Rinse thoroughly with tap water.

3.9.3 Well Casing Cleaning

These protocols are included and are meant as RECOMMENDATIONS for cleaning well casing and riser pipes. Recommendations from other regulatory programs, if different or more stringent shall be followed.

- a. PVC pipe that is designed for well casing shall be transported to the

field in original packing boxes.

- b. Other PVC casing (for plumbing, etc. uses) shall be prepared for cleaning by sanding stencils (if present) on those portions of riser pipe that may come in contact with formation water. The ink used for stenciling may contribute to or contaminate the real samples. Casing that has been contaminated with grease, hydraulic fluid, petroleum fuel, etc. may require additional cleaning or deemed unusable.
- c. All casing and riser pipe should be cleaned just prior to installation using the following protocol:
 - 1. Steam clean all casing and riser pipe. Steam cleaning criteria shall meet the following: water pressure - 2500 psi, water temperature - 200°F.
 - 2. Rinse thoroughly with tap (potable) water. This tap water must be free of the analytes of interest, in effect analyte-free. Some potable water sources may have very low levels of contamination (e.g. benzene, trihalomethane, trichloroethane). A potable water source should only be used if it is known to be free of those contaminants that are being investigated.

3.10 ANALYTE-FREE WATER CONTAINERS

Analyte-free water containers made be constructed of glass, Teflon, polypropylene, or high density polyethylene (HDPE). It is strongly recommended that inert glass or Teflon be used for containerizing organic-free sources of water. Polypropylene is a good second choice. HDPE, though not recommended, is acceptable. Analyte-free water should not be left in these containers for extended periods, especially HDPE. These containers should be filled up for a single sampling event and then emptied at the end of the sampling day. EPA's cleaning procedure for

glass (Teflon and polypropylene) is as follows:

3.10.1 New Containers

- a. Wash per instructions in 3.4.1 (delete solvent rinse if plastic (HDPE or polypropylene) containers are being cleaned).
- b. Cap with Teflon film, aluminum foil or the bottle cap. Note: the bottle cap shall be equipped with a teflon liner. Aluminum foil or teflon film may be used as liner material.

3.10.2 Reused Containers

- a. Immediately after being emptied, cap with aluminum foil, teflon film or the container cap.
- b. Wash container exterior with lab-grade detergent solution and rinsed with DI water
- c. Rinse interior twice with isopropanol (delete if containers are plastic, see 3.10.1a above)
- d. Rinse interior thoroughly with analyte-free water,
- e. Invert and allow to drain and dry
- f. Fill container with analyte-free water and cap tightly with aluminum foil, Teflon film or the container cap. Note: the bottle cap shall be equipped with a teflon liner. Aluminum foil or teflon film may be used as liner material.
- g. Water shall not be stored for more than 3 days prior to a sampling trip.

3.11 ICE CHESTS AND SHIPPING CONTAINERS

- a. Wash exterior and interior of all ice chests with laboratory detergent (see 3.4.1 NOTE 3).
- b. Rinse with tap water and air dry before storage.

- c. If the ice chest becomes severely contaminated with concentrated waste or other toxic or hazardous materials, it should be cleaned as thoroughly as possible, rendered unusable, and properly disposed.

4.0 AQUEOUS SAMPLING PROCEDURES

4.1 General

There are several requirements that are common to all types of surface water sampling events and are independent of technique. Several of these requirements are concerned with sample parameters that are inherently difficult to sample. In addition to the below procedures, overall care must be taken in regards to equipment handling, container handling/storage, decontamination, and record keeping.

- a. Sample collection equipment and non-preserved sample containers must be rinsed with sample water before the actual sample is taken. Exceptions to this are: oil & grease, TRPH, microbiological, VOCs, or any pre-preserved container.
- b. If protective gloves are used, they shall be clean, new and disposable. These should be changed prior to moving to the next sampling point.
- c. Sample containers for source (i.e. concentrated wastes) samples or samples suspected of containing high concentrations of contaminants shall be placed in separate plastic bags immediately after collecting, preserving, tagging, etc.
- d. If possible, ambient, or background samples should be collected by different field teams. If separate collection is not possible, the ambient or background samples shall be collected first and placed in separate ice chests or shipping containers. Highly contaminated samples shall never be placed in the same ice chest as environmental samples. It is a good practice to enclose highly contaminated samples in a plastic bag before placing them in ice chests. Ice chests or shipping containers with samples suspected of being highly contaminated shall be lined with new, clean, plastic bags.
- e. If possible, one member of the field team should take all the notes, fill out tags, etc., while the other member does all of the sampling.

- f. Teflon or glass is preferred for collecting samples where trace contaminants are of concern. Equipment constructed of rubber or plastic (e.g., PVC, Tygon, most Van Dorn Samplers) shall not be used to collect samples for trace organic compound analyses.

4.2 Special Parameter - Specific Handling Procedures

- a. Since the concentration standards and/or guidance criteria for many analytes are in the (sub)parts per billion range, extreme care must be taken to prevent cross-contamination.
- b. Most of the parameter groups listed in sections 4.2.1 through 4.2.8 below, shall be taken as grab samples unless regulatory requirements dictate otherwise. The exceptions are extractable organics and total metals which may be taken as composites, if required.
- c. There is a greater chance of cross contamination when collecting composites because of increased sample handling and more equipment.
- d. The following eight categories of parameters have specific sampling techniques and considerations which must be followed to collect unbiased, uncontaminated samples.

THE PROCEDURES OUTLINED BELOW SHALL BE USED FOR ALL AQUEOUS SAMPLING (I.E. SURFACE WATER, WASTEWATER, GROUNDWATER, STORMWATER ETC.).

4.2.1 Metals Sampling

4.2.1.1 Sample containers

- a. New or properly cleaned plastic containers may be used for metals sampling. Glass bottles may also be used, but they are prone to breakage and occasionally react with the sample to

either leach or adsorb metals from the glass itself.

- b. All containers for metals sampling, new or previously used, shall be cleaned by following protocols outlined in Section 6.1.
- c. Visually inspect polyethylene or glass containers for defects or contamination. Discard if defects are present or containers do not appear clean.

4.2.1.2 Preservation

- a. Samples shall be preserved with nitric acid (HNO₃) of a grade that is suitable for use in trace metals analysis.
- b. Preservation shall occur within 15 minutes of sample collection or filtration (if applicable) unless collected as a 24-hour composite.
- c. Adequate HNO₃ shall be added per liter of sample to reduce the pH to below 2.0 to keep metals in solution and prevent them from adsorbing or absorbing to the container wall.
- d. If only dissolved metals are to be measured, the sample shall be filtered immediately after sample collection through a 1.0 μ m membrane filter for groundwater and a 0.45 μ m membrane filter for surface water. The sample shall not be preserved before filtration. See Table A-1 for approved filtration equipment.
- e. Samples submitted for Chromium VI should not be acidified.

4.2.1.3 Sample collection protocol:

- a. Remove the cap from the sample container and rinse container with sample water (IF NOT PRE-PRESERVED). Carefully pour sample into the container without allowing the sampling device to touch the rim of the sample container.

- b. If adding preservatives in the field, the sample container should not be filled to capacity.
- c. Acidify the sample to pH of 2 or less by adding a measured quantity of concentrated HNO₃ or 1+1 HNO₃ into the container.
- d. NOTE: If containers are pre-preserved by a subcontract laboratory, the sample must be poured into the container slowly to prevent the acid from splattering. As a precautionary note, the addition of water to acid can generate enough heat to burn unprotected hands.
- e. Tightly cap the sample container and shake to distribute the acid. Pour an aliquot of the acidified sample into a disposable container (e.g. sampling cup) or onto a piece of NARROW range pH paper to determine if the pH is less than 2.0. DO NOT PUT THE pH PAPER DIRECTLY INTO THE SAMPLE CONTAINER!
 - 1. Field experience has shown that UNDER NORMAL CIRCUMSTANCES, 2 ml of concentrated HNO₃ added to 250 ml of sample water will reduce the pH to less than 2.
 - 2. If the pH is greater than 2, add additional MEASURED amounts of acid until the pH has been reduced.
 - 3. Record the total amount of acid that was added to the sample. This documentation is necessary for the next site visit, since additional acid may need to be added to the sample on subsequent visits.
 - 4. Acidify at least one of the equipment blank(s) with the GREATEST amount of acid that was required in the

sample set and note the amount in field documentation.

- f. Following proper sample preservation, tightly cap, affix a sample label, apply a seal (if required), and complete the chain of custody.
- g. Aqueous samples for metals need not be cooled to 4° C.
- h. Make a note on the transmittal form identifying samples that have entrained sediment.

4.2.1.4 Filtration

- a. For certain studies or projects, it may be necessary to obtain dissolved (i.e. filtered) samples. All samples that are filtered shall be identified in field notes and on final reports as "dissolved" or "filtered" metals.
- b. Specific protocols for collecting dissolved metals from groundwater samples are discussed in Section 4.5.6.4. Filtered samples SHALL NOT be collected from groundwater sources unless:
 - 1. The Project Manager feels that the contamination is directly related to the suspended material rather than the groundwater. In this case, BOTH unfiltered and filtered samples shall be collected and analyzed.
- c. Surface water samples may use the sample protocols that are specified for groundwater (Section 4.5.6.4) These protocols are recommended when sampling static surface water sources (i.e. subsurface samples from lakes, ponds, lagoons or ocean) since exposure to air can change the concentration of metals in solution. When sampling from moving sources (i.e. rivers or streams) or just below the surface, filtered samples may be

collected into an intermediate container and filtered with syringe-type or tripod type filtration units.

- d. Allowing a sample to settle and decanting the supernate (upper water layer) has been proposed as a means of removing suspended material. This technique MAY NOT be used for groundwater samples, and is not recommended for other sources because:

1. Settling times techniques are highly dependent on particle size and concentration and may not be reproducible;
2. Preservation for metals must occur within 15 minutes of sample collection which may not be sufficiently long for highly turbid samples to settle; and
3. The analytical results cannot be reported as "total" or "dissolved".

If this technique is used, the following protocols must be followed:

1. Samples shall not be acidified before settling occurs;
2. Total time for settling shall not exceed 15 minutes;
3. The resultant supernate shall be carefully decanted into an appropriate container and preserved using protocols described above;
4. Field notes shall specify the length of time the sample was allowed to settle, as well as observations on the initial and final (supernate); and
5. The final report shall identify the technique that was used to collect the sample (i.e. decanted).
6. NOTE: samples SHALL NOT be transported back to the laboratory for settling, UNLESS entire procedure

(transport, settling, decanting and preservation) can occur within 15 minutes of sample collection.

4.2.2 Extractable Organics and Pesticides

Conventional sampling practices shall incorporate the following special considerations. Oil & Grease (O&G) and Total Recoverable Petroleum Hydrocarbons (TRPH) shall follow protocols outlined in Section 4.2.5 below.

4.2.2.1 Sample containers

- a. Collect all samples in glass containers (1 liter to 1 gal.) with Teflon-lined caps. Note: Teflon containers are also acceptable.
- b. Amber glass should be used for PAHs, nitrosamines, nitroaromatics, and isophorone.
- c. Visually inspect glass bottles to assure that there are no glass or liner defects. If defects are present and/or the sample containers do not appear clean, the bottles must be discarded.
- d. Sample containers must be cleaned according to the protocols specified in Section 6.1.
- e. Composite samples from automatic WW samplers must be collected in refrigerated glass containers through Teflon tubing.

4.2.2.2 Preservation

- a. Table A-2 must be followed to determine the specific preservation method for each group of organic compounds and pesticides.
- b. All samples must be placed on wet ice immediately after collection. Samples must be maintained at a temperature of 4° C.

- c. If the samples for pesticides cannot be extracted within 72 hours of collection, the sample pH must be in the range of pH 5 to 9. If needed, sample must be adjusted to the specified pH range with sodium hydroxide or sulfuric acid.
- d. Other extractable samples need not be pH-adjusted with acid or base.
- e. Samples must be extracted within 7 days of sample collection and the extracts analyzed within 40 days of extraction.
- f. If residual chlorine is present, sodium thiosulfate must be added.

4.2.2.3 Sample collection protocol:

- a. Sample bottles should be prerinsed with sample before collection, except Total Recoverable Petroleum Hydrocarbons (TRPH), Oil & Grease, etc. or any prepreserved sample container.
- b. Remove the cap from the bottle without touching the Teflon liner.
- c. Do not allow the sampling equipment or hands to touch the rim of the sample container.
 - 1. For bailer sampling, it may be necessary to utilize a stainless steel or Teflon delivery tube (fits into the bottom of the bailer).
- d. Fill bottle with sample to almost full capacity.
- e. Quickly place the Teflon lined cap over the bottle and tighten securely.
- f. Affix a sample label, seal (if required), and complete the chain-of-custody form.
- g. Put the sample bottle in a plastic sample bag and place on wet ice immediately.

- h. Make a note on the lab transmittal form identifying samples that appear highly contaminated or exhibit other abnormal characteristics (i.e. foaming, odor, etc.).

4.2.3 Volatiles Sampling

4.2.3.1 Sample containers

- a. Analysis of volatile organic substances requires a glass sample vial, sealed with a teflon-coated septum.
- b. AT A MINIMUM, duplicate samples must be collected, although some laboratories require three or more vials. If the containers are not supplied by the laboratory, verify the laboratory's policy on how many vials are necessary and collect the specified number of vials.
- c. Visually inspect the glass vials to assure that there are no glass or septum defects (e.g. rim must have not nicks or visible depressions); septum must not be deformed, etc.). If defects are present and/or sample containers or septums do not appear to be clean, the vials must be discarded.
- d. Sample vials may be purchased precleaned from commercial vendors, or must be cleaned according to protocols outlined in Section 6.1.
- e. NOTE: VIALS FOR VOCS ARE NOT RINSED WITH SAMPLE.

4.2.3.2 Preservation

- a. Table A-2 must be followed to determine the specific preservation method for each group of volatile organic compounds.

- b. If residual chlorine is not present, the vials shall be filled with the sample, acidified (prepreserved containers are acceptable) with HCl and labeled "preserved".
- c. If the volatile aromatics are to be analyzed within 7 days, HCl is not necessary.
- d. Sodium thiosulfate must be added to samples with residual chlorine (see sampling protocols below).
- e. Samples must be placed on wet ice immediately after sample collection. A temperature of 4°C must be maintained until the sample has arrived at the laboratory.

4.2.3.3 Sample collection protocols:

- a. All fuel or exhaust sources which could cause VOC contamination must be situated well away and downwind of the sampling site.
 - 1. If possible, fuels should be transported and stored in a separate vehicle from empty vials and collected samples.
 - 2. All petroleum fueled engines (including the vehicle) must be situated downwind of the sampling operations.
- b. Samples shall not be aerated during sample collection.
 - 1. Extreme caution must be exercised when filling a vial to avoid any turbulence which could promote volatilization.
 - 2. Carefully pour the sample down the SIDE of the vial to minimize turbulence. As a rule, it is best to gently pour the last few drops into the vial so that surface tension holds the water in a "convex meniscus."
- c. Do not allow the sampling equipment to touch the rim of the sample container.

1. For bailer sampling, it may be necessary utilize a stainless steel or Teflon delivery tube or "pigtail" to obtain a gentle trickle of sample into the vial.
 2. It is sometimes difficult to completely fill the vial directly from some waste streams. The sample may be collected in a precleaned intermediate sample collection device made of the appropriate materials (see Table A-1) and carefully poured into the VOC vials.
- d. The investigator must determine if the water to be sampled contains residual chlorine.
1. If residual chlorine is present; add 10 mg of sodium thiosulfate to the vial (laboratory may supply vials with premeasured quantities).
 2. Fill the vial 90% with sample.
 3. Add four drops of concentrated HCl (more acid may be needed if the sample is known to contain high levels of bicarbonate or is otherwise buffered). Add additional sample (if needed) to create a convex meniscus and cap with zero headspace (see "e" below).
 4. Label vial appropriately (preserved/sodium thiosulfate/acid).
- e. The sample must be collected so that there are no air bubbles in the container after the screw cap and septum seal are applied.
1. Vial must be filled so that the sample surface is above the container rim (convex meniscus).
 2. The cap with the septum is then quickly applied (make sure teflon side of septum is down). Some sample may overflow, but air space in the bottle must be eliminated.

3. If acid has been added to the sample, tip the vial gently two or three times to distribute the preservative.
 4. Turn the bottle over and tap it to check for bubbles. If any are present, remove the cap, add a few more drops of sample, recap and test for bubbles. REPEAT NO MORE THAN 3 TIMES.
- f. Sampling and preservation containers may be prelabeled prior to any field activities. This may reduce confusion during a sampling event.
 - g. All the vials must be labeled. Make note in the field records of any samples that appear highly contaminated or appear to effervesce when acid is added.
 - h. Wrap each vial in bubble-wrap, or equivalent, and place each vial in a small ziplock-type bag and immediately place on wet ice.
 - i. Complete field records.
 - j. Protect samples from environmental contamination during storage and transport to the laboratory.
 1. As an added measure, replicate samples may be sealed in a container with vermiculite. This will add further protection from potential contamination.

4.2.4 Bacteriological Sampling

4.2.4.1 Sample containers

- a. Samples must be collected in containers that have been sterilized according to Standard Methods (17th Edition) or the EPA's Microbiological Methods for Monitoring the Environment, 14th edition.

1. Presterilized Whirlpak bags (or equivalent) are typically used for sampling.
2. If Whirlpaks are not used, a 125 ml or larger sample container must be used to provide a minimum sample volume of 100 ml and adequate mixing space.
- b. Unlined caps or ground glass tops shall be used to ensure complete sterilization of the container's closure.
- c. Bottles and caps shall be sterilized according to protocols outlined in Section 6.1 or purchased presterilized from a commercial vendor.

4.2.4.2 Preservation

- a. Samples shall be preserved according to Table A-2.
- b. All samples shall be place on wet ice immediately after sample collection.
- c. When sampling water containing residual chlorine, a dechlorinating agent such as sodium thiosulfate must be added to the sample container.
 1. The final concentration of sodium thiosulfate in the sample shall be approximately 100 milligram per liter (mg/L) in the sample.
 2. As a general rule, this concentration may be achieved by adding 0.1 ml of a 10 percent solution of sodium thiosulfate to a 125 ml sample bottle.
 3. The dechlorinating agent neutralizes any residual chlorine and will prevent further reaction between bacteria and chlorine.
- d. ANALYSIS MUST COMMENCE WITHIN 6 HOURS FOR

NON-POTABLE SOURCES AND 30 HOURS FOR POTABLE SOURCES. Special laboratory arrangements may need to be made so that the holding times are not compromised (may require local lab analysis).

4.2.4.3 Sample Collection Protocols:

- a. Bacteriological sampling must always be collected as a grab sample and must never be composited.
- b. The container must be kept unopened until the moment that the sample is collected.
- c. DO NOT RINSE CONTAINER BEFORE COLLECTING SAMPLE.
- d. When the Whirlpak bag or sample bottle must be lowered into the waste stream, either because of safety or impracticality (manhole, slippery effluent area, etc.), care must be taken to avoid contamination.
- e. Samples shall never be collected in an unsterilized sample container and transferred to a sterile container.
- f. Be careful not to put fingers into the mouth of the container or on the interior of the cap.
- g. If sampling intermediate sampling devices (i.e. bailers) or from in-place plumbing, the sampling device or the tap do not need to be disinfected (i.e. swabbing with alcohol or flaming with heat source).
 1. Intermediate sampling devices shall be thoroughly rinsed with sample water prior to collecting the sample. For this reason, microbiological samples should be among the final samples that are collected from the sampling

location.

2. Spigots shall be flushed at maximum velocity (see Section 4.6) to purge the system and remove particulates. Sample flow shall be reduced to approximately 500 ml/min and allowed to run a few minutes before collecting samples (or microbiological samples may be collected last). **DO NOT STOP FLOW BEFORE OR DURING THE FILLING PROCESS.**
- h. Surface water sample collection:
1. To sample with a rigid container, hold the bottle near the base and plunge neck downward, below the surface. Turn container until the neck points slightly upward with the mouth directed toward the current. Fill to within about 1/2 inch of the top and recap immediately.
 2. To sample with a Whirlpak bag, open the bag by zipping off the top and pulling the white tabs to open the bag. Hold the bag in the hand or attach to a long handle and plunge neck downward and up in one sweeping arc.
- i. Intermediate containers (i.e. bailers)
1. Obtain sufficient sample in the sample collection device to completely fill the sample container.
 2. Begin pouring sample out of the device **BEFORE** collecting into the container.
 3. Continue to pour sample out of the device, place container under flowing stream, and fill. **DO NOT STOP FLOW BEFORE OR DURING THE FILLING PROCESS.**
- j. Wells with in-place plumbing, spigots and/or faucets

1. Samples shall be collected after flow has been reduced to 500/ml per minute.
2. Allow the water to flow at the reduced rate for a few minutes before collecting the sample, or collect all other samples prior to taking the microbiological sample.
3. DO NOT STOP FLOW BEFORE OR DURING THE FILLING PROCESS.

4.2.5 Oil and Grease (O&G) and Total Recoverable Petroleum Hydrocarbon (TRPH) Sampling

4.2.5.1 Sample Containers

- a. Samples for O&G and TRPH shall be collected in 1 liter wide-mouth glass bottles.
 1. The lid shall be teflon-lined.
 2. If the cap is not teflon-lined, a sheet of teflon extending out from the lid may be used.
- b. Visually inspect glass bottles to assure there are no glass or cap defects. If defects are present and/or sample containers do not appear to be clean, the bottles should be discarded.

4.2.5.2 Sample Preservation

- a. Since losses of the product will occur on sampling equipment, composite samples shall not be collected.
- b. The sample must be immediately preserved by adding H₂SO₄ or HCl to reduce the pH to 2.0 or less.
- c. Samples must be placed on wet ice immediately after preservation. The temperature of the sample must be maintained at 4°C until received and processed by the

laboratory.

4.2.5.3 Selection of Sampling points

- a. Oil and grease may be present in wastewater as a surface film, an emulsion, a solution, or as a combination of these forms. Since it is very difficult to collect a representative ambient sample for oil and grease analysis, the sampler must carefully evaluate the location of the sampling point.
- b. The most desirable sampling location for both O&G and TRPH is the point where greatest mixing is occurring. Quiescent areas should be avoided, if possible.
- c. Skimming the surface for the sample is unacceptable.
- d. For compliance samples at a facility you may want to take samples at the worst place.
- e. Neither the container, nor the sampling device, shall be rinsed before the actual sample is taken.
- f. COMPOSITE SAMPLES SHALL NOT BE COLLECTED. If composite data is required, individual grab samples that are collected at prescribed time intervals must be analyzed separately to obtain the average concentrations over an extended period.

4.2.5.4 Sampling Protocols

- a. Sampling for these products is unique because they are immiscible and tend to adhere to the sampling device; therefore, these sample shall always be a grab sample.
- b. The sample, when collected, should not be transferred to another container. The analytical methods require the use of the

entire sample. In addition, the sample container must be rinsed with solvent as a part of the laboratory analytical process. Therefore these samples must be separate and discrete samples that will be used only for the O&G or TRPH analysis.

- c. Remove the cap from the glass bottle without contacting the interior of the container or lid.
- d. DO NOT RINSE THE BOTTLE WITH SAMPLE WATER.
- e. Whenever possible samples should be collected directly into an unpreserved sample container. If intermediate sampling equipment is used, do not allow the sampling equipment to touch the rim of the sample container. AUTOMATIC SAMPLERS SHALL NOT BE USED TO COLLECT THESE TYPES OF SAMPLES.
- f. Fill the bottle with the sample water to almost full capacity.
- g. Add preservatives and check the pH using the protocols outlined in 6.2.2.b.
- h. Quickly cap the container and tighten securely.
- i. Affix a sample label, seal (if required), and complete the chain-of-custody form.
- j. Protect glass container from breakage ("bubble wrap" is recommended), place the sample bottle in a plastic sample bag and keep it cool to 4°C on wet ice.
- k. Make a note on the lab transmittal form identifying samples that may be highly contaminated or any other unusual observations.

4.2.6 Radiological Sampling (Excludes Radon)

4.2.6.1 Sample containers

- a. Polyethylene, polyvinyl chloride (PVC), or Teflon containers

are recommended for collecting radioactive samples because these containers are less adsorbent than glass or metal containers. Since radioactive elements are often present in extremely low quantities, a large fraction of the elements may be lost by adsorption on containers or glassware surfaces used in analyses. This loss may, in turn, cause a loss of radioactivity and possibly contaminate subsequent samples due to reuse of inadequately cleaned containers. Glass bottles are also more susceptible to breakage during handling than plastic containers.

- b. Containers shall be cleaned according to the protocols specified in Section 6.1.

4.2.6.2 Preservation

- a. The preservation technique for radiological sampling is acidification to a pH of less than 2.0 with concentrated or 1+1 nitric acid (HNO₃).
- b. The pH shall be checked in the field following the protocols described 6.2.2.b.

4.2.6.3 Sampling Protocols

Prior to sampling, the area may be surveyed with a beta-gamma survey instrument, such as a Geiger-Maller meter. If radiation levels are above instrument background, the investigator should consult a radiation safety specialist to determine appropriate safety procedures.

4.2.7 Radon Sampling

Radon is a gas and is easily removed from water sources. Therefore, the same precautions and care used to collect volatile organic samples shall be

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followed. It is extremely important to minimize contact with air during sample collection.

4.2.7.1 Sample Containers

- a. Glass sample vials shall be obtained from the analyzing laboratory and shall contain a premeasured portion of the scintillation "cocktail".
- b. A minimum of two samples is required. Laboratories are expected to provide the sampler with the requisite number of containers for each sample.

4.2.7.2 Preservation

The scintillation cocktail is the only required preservative.

4.2.7.3 Sampling Protocol

The laboratory should provide specific sample collection instructions that must be followed. These protocols should included proper handling as well a sample size and packing instructions. The following are general instructions that should be used:

- a. Carefully fill a syringe (usually 10 ml) with sample water so that air bubbles are not pulled in with the sample before, during or after filling.
- b. Place the tip of the syringe **BELOW** the scintillation cocktail and slowly dispense the sample **BENEATH** the cocktail surface.
- c. Replace lid and cap tightly.
- d. Generally the vial is used in the laboratory analytical instrument and labels or ID numbers on the sides of the containers may interfere with the analysis. Check with the laboratory for

proper placement of labels or field ID numbers.

- e. Ship in an upright position in the shipping containers that have been provided by the laboratory. If none are provided, protect vials from breakage (bubble wrap is recommended), segregate replicate samples in separate plastic bags, and ship to laboratory in an upright position.

4.2.8 Cyanide Sampling

Cyanide is a very reactive and unstable compound. Cyanide should be analyzed as soon as possible after collection.

4.2.8.1 Sample Containers

- a. The sample container shall be polyethylene or glass.
- b. Containers shall be cleaned in accordance with protocols outlined in Section 6.1 of this manual.

4.2.8.2 Preservation

- a. All samples shall be preserved to a pH of greater than 12 with sodium hydroxide and placed on wet ice immediately after preservation. A temperature of 4°C shall be maintained until analysis begins at the laboratory. The pH of the samples shall be checked to assure proper pH (see 6.2.2.b).
- b. All samples known to contain oxidizing agents (chlorine) must first be tested as follows:
 - 1. Test sample with KI-starch paper;
 - 2. Add a few crystals of ascorbic acid, mix sample and retest.
 - 3. Continue to add ascorbic acid until the test is negative;

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4. Add an additional 0.6 grams of ascorbic acid per liter of sample to remove chlorine.

4.3 Surface Water Sampling

4.3.1 Introduction and Scope

This section presents the standard operating procedures that shall be employed during field investigations to ensure that representative surface water samples are collected. The particular surface water types that will be addressed include; static lakes, ponds, and impoundments; tidally-influenced estuarine areas; as well as streams and rivers. Care should be taken so that samples are neither altered nor contaminated by sample handling procedures.

This section discusses grab, depth-specific, and depth composited surface water samples. Information regarding flow- or time-weighted aqueous sampling is found in the Wastewater Sampling section.

4.3.2 General

Access will be left up to the sampling group. Ease of access should not be the main criteria for sampling site choice. If sampling from a bridge, by boat, or by wading, there are certain precautions that must be considered:

- a. If sampling with a boat, samples should be taken from the bow, away and upwind from any gasoline outboard engine.
- b. Collect samples upstream from the body when wading in to collect water samples.
- c. Care should be taken not to disturb sediments when taking samples in lakes, ponds, impoundments.
- d. If water samples and sediment samples are to be taken from the same area, the water samples must be taken first.

- e. Sampling at or near structures (dams, weirs, bridges) may not provide representative data because of unnatural flow patterns.
- f. Surface water and/or sediments should always be collected from downstream to upstream.

4.3.3 Sample Acquisition

Three (3) types of general sample acquisition methods will be discussed: grab samples; mid-depth samples; and composite samples.

4.3.3.1 Grab Sampling

- a. If the sample media is homogenous, grab samples are an effective and simple technique. If homogeneity is not known (and should never be assumed) then other techniques must be used.
- b. Surface grabs using unpreserved sample containers are encouraged since the sample container is used for collecting the sample and, after appropriate preservation, the same container can be submitted for laboratory analysis. This reduces sample handling and eliminates potential contamination from other sources (i.e. additional sampling equipment, environment, etc.). If the laboratory provides prepreserved sample containers, the sample shall be collected in an UNPRESERVED sample container or with sampling equipment. The container or equipment shall be of appropriate construction (see Table A-1) and the sample shall be transferred immediately into the prepreserved sample container.
- c. Simple Grab Samples - Typical sample collection equipment includes not only sample containers, but also precleaned

beakers, buckets, and dippers. These samplers must be constructed appropriately (including handles):

1. Sample Container (unpreserved)

- a) submerge the container, neck first into the water,
- b) invert the bottle so the neck is upright and pointing into the water flow (if applicable),
- c) return the filled container quickly to the surface,
- d) shake to rinse the interior surface of the container and pour contents out downstream of sample location (see restrictions outlined in 2.3)
- e) Collect sample as described in steps a, b and c above.
- f) pour out a few mls of sample downstream of sample collection. This allows for addition of preservatives and sample expansion
- g) Securely cap container, and label.

2. Intermediate vessel

- a) Collect sample as outlined in C.1. above.
- b) Pour into prepreserved sample container (or field preserve per Section 6.2.2.a), check pH per Section 6.2.2.b (if applicable), cap, and label.

- d. Pond Sampler - Another effective technique is using a pole-mounted flask, beaker, or container. A long, telescoping pole (swimming pool supply) is outfitted with a (non-contaminating) clamp. An appropriately constructed and shaped container is fitted into the clamp. In this way the sample can be taken away from the shore, boat, bridge, etc. and at a specific spot. The sampling vessel can be constructed of all-inert material so that

all parameters can be sampled.

1. Submerge the clamped container neck first, invert and withdraw from water.
 2. Be careful not to entrain sediments or skim the water surface.
 3. Rinse container (restrictions specified in Section 2.3 must be observed), resubmerge and collect sample. Retrieve the pole, clamp, and container and fill the sample containers.
- e. Pump and Tubing - Although the use of a peristaltic pump and tubing can provide an adequate mid-depth or depth composite, it can also be used for taking a grab sample. This would be especially helpful if a large amount of sample is needed.
1. Lower appropriately precleaned tubing to a depth just below the water surface (6 - 12 inches).
 2. Turn the pump on.
 3. Allow several tube volumes to pump through the system to acclimate the tubing.
 4. Make sure the tubing does not come out of the water and inadvertently pull some surface skim water through the tubing (this may bias sample results).
 5. Fill the individual sample bottles via the discharge tubing.

NOTE: THIS TECHNIQUE IS NOT ACCEPTABLE FOR OIL & GREASE, TRPH OR VOCs. It is not recommended for extractable organics or microbiologicals (new, unused tubing, including tubing in the sampling head are required at each sampling location).

4.3.3.2 Mid-Depth Sampling

- a. Mid-depth samples or samples taken at a specific depth can approximate the conditions throughout the entire water column.
 1. One sample may be taken when the water body is assumed to be homogenous.
 2. Additional samples can be taken from different depths at one spot to get a much more exact approximation of the conditions.
 3. Many times a single site will be sampled from: just below the surface; mid-depth; and just above the bottom (sediment).
 4. Accurate sampler location is imperative for this sampling technique.
- b. The equipment that may be used for this type of sampling are:
 - a device designed specifically for depth-specific sampling (kemmerer, niskin, beta, etc.); pumps with tubing; or double check valve bailers.
 1. Samplers are available from many manufacturers and in a variety of configurations and construction materials.
 2. Certain construction material details may preclude a device's use for certain parameters (see Table A-1):
 - a) Many kemmerer samplers are constructed of plastic and rubber which precludes their use for all organic sampling parameters (volatile and semivolatile).
 - b) Some of the newer devices are constructed of stainless steel or are all-Teflon or Teflon coated. These would be acceptable for all parameter

groups without restriction.

- c) NOTE THAT ALL RELATED COMPONENTS (STOPPERS, ETC.) MUST BE CONSTRUCTED OF INERT MATERIAL AS WELL IF ORGANICS ARE TO BE SAMPLED.

c. Kemmerer, niskin, and beta type devices

- 1. Separate and specific deployment discussions are not provided in this document. Manufacturers suggestions shall be followed for specific procedures.
 - a) Before lowering the sampler, measure the water column to determine maximum depth and sampling depth.
 - b) The line attached to the sampler should be marked with depth increments so that the sampling depth can be accurately recorded.
 - c) When dropping the sampler to the appropriate depth, it should be done slowly so that sediments are not stirred up.
 - d) Once the desired depth is reached, send the messenger weight down to trip the mechanism.
 - e) The sampler should be lowered and retrieved slowly.
 - f) The first sample shall be discarded into a bucket (to be dumped at conclusion of sampling).

d. Double check-valve bailers

- 1. Sampling with these type of bailers shall follow the same protocols outlined in "c" above.
- 2. Although not designed specifically for this kind of

sampling, it will be acceptable when a mid-depth sample is required.

3. Note: this sampler does not perform as well as the devices described above or the pump and tubing described in the next section.
 4. As the bailer is dropped through the water column, water will be displaced through the body of the bailer. The degree of displacement is dependent upon the check valve ball getting out of the way and allowing water to flow freely through the bailer body.
 5. An open-top bailer may also be used, but is not recommended. The open-top arrangement will not prevent water from being exchanged in the top portion of the bailer.
 6. A closed-top bailer does not allow free water displacement on descent at all and is not acceptable.
 7. The bailer should be dropped slowly to the appropriate depth. Upon retrieval, the (two) check valves seat, preventing water from escaping out of or entering the bailer.
- e. Pump and Tubing
1. The most portable pump for this technique is a (12 volt) peristaltic pump.
 2. Appropriately precleaned silastic is required in the pump head and HDPE, Tygon, etc. tubing is attached to the pump.
 3. Measure the water column to determine the maximum depth and the sampling depth.

4. Tubing will need to be tied to a stiff pole or be weighted down so the tubing placement will be secure.
 - a) A lead weight should not be used.
 - b) Any dense, non-contaminating, non-interfering material will work (brick, SS weight, etc.).
 - c) Tie the weight with a lanyard (braided or monofilament nylon, etc.) so that it is located below the inlet of the tubing.
5. Turn the pump on and allow several tubing volumes of water to be discharged before taking the first sample.
6. Sample containers are then filled in the proper order, preserved, labeled, and placed on ice (if required).

4.3.3.3 Composite Sampling

Composite sampling will be used when a single sample that approximates a given depth interval is desired. Any of the devices described in mid-depth sampling can be used for composite sampling. The devices must be activated or manipulated in a way that the actual volumes sampled within the interval are ALL EQUAL PROPORTIONS. For instance, because of head pressure, the pump and tubing will pull a greater volume of sample at 5 feet in comparison to 20 feet. For this reason, great care must be used so that sample results are not biased. The use of the niskin, kemmerer, beta, bailers, etc. containers may take more time, but sample control will be greater.

4.4 Wastewater Sampling

4.4.1 Introduction and Scope

Prior to mobilizing, the sampler must decide what kind of samples to collect, for what parameters, and where to collect them. Care must be taken to ensure that the sampling location is correct and that the samples are representative of the discharge.

This section is also applicable to stormwater runoff sampling.

4.4.2 Sample Types

There are two primary types of samples: 1) grab samples; and 2) composite samples. Each type has distinct advantages and disadvantages. In order to obtain a more complete characterization of a specific facility's effluent, the two sample types can be used independently or in combination.

4.4.2.1 Grab Samples

- a. This is an individual sample collected over a period of time, usually all in one motion, generally not exceeding 15 minutes. The 15 minute time limit applies to aqueous samples only. No particular time limit applies to the collection of solid samples (e.g. residuals). Grab samples may be used to determine consistency between an industry's self-monitoring data and to corroborate the results of composite samples.
- b. Grab samples represent the conditions that exist at the moment the sample is collected and do not necessarily represent conditions at any other time. Grab sampling is the preferred method of sampling under the following conditions:
 1. A snapshot of the wastewater quality at a particular

- instant in time is desired; and
2. The water or wastewater stream is not continuous (e.g., batch discharges or intermittent flow);
 3. The characteristics of the water or waste stream are known to be constant or nearly so;
 4. When the waste conditions are relatively constant over the period of discharge. In lieu of complex sampling activities, a grab sample provides a simple and accurate method of establishing waste characteristics;
 5. The sample is to be analyzed for parameters whose characteristics are likely to change significantly with time (i.e., dissolved gases, bacteria, pH, etc.);
 6. The sample is to be collected for analysis of a parameter such as oil and grease or bacteriologicals where the compositing process could significantly affect the actual concentration;
 7. Data on maximum/minimum concentrations are desired for a continuous water or wastewater stream; and
 8. Identifying and tracking slug loads and spills.
- c. If required to be measured, the following parameters shall be measured on grab samples or in-situ. NOTE: If the permit specifies a composite sample for any of the above-mentioned parameters, THE PERMIT CONDITIONS SHALL BE FOLLOWED.

pH

phenol

temperature

oil and grease

dissolved oxygen	bacterial
sulfide	volatile organic compounds
chlorine residual	specific conductance
other dissolved gases	cyanide
un-ionized ammonia	dissolved constituents in field filtered samples (ortho-P, metals, etc.)

- d. Sampling protocols shall follow those outlined under Surface Water (4.3.3.1).

4.4.2.2 Composite Samples

- a. A composite sample is a sample collected over time, formed either by continuous sampling or by mixing discrete samples. Composite samples reflect the average characteristics during the compositing period.
- b. Composite samples are used when stipulated in a permit and when:
 1. The water or wastewater stream is continuous;
 2. Analytical capabilities are limited;
 3. Determining average pollutant concentration during the compositing period;
 4. Calculating mass/unit time loadings; and
 5. Associating average flow data to parameter concentrations.
- c. Composite samples may be collected individually at equal time intervals if the flow rate of the sample stream does not vary more than plus or minus ten percent of the average flow rate, or they may be collected proportional to the flow rate. The permit may specify

which composite sample to use, either time composites or flow proportional composites. The compositing methods, all of which depend on either continuous or periodic sampling, are described in the following discussions.

d. Time Composite Sample

1. Time composite samples are based on a constant time interval between samples.
2. A time composite sample can be collected manually or with an automatic sampler.
3. This type of composite is composed of discrete sample aliquots collected in one container at constant time intervals.
4. This method provides representative samples when the flow of the sampled wastewater stream is constant. This type of sample is similar to a sequential composite sample (described below).

e. Flow Proportional Composite Sample

1. Flow proportional samples can be collected automatically with an automatic sampler and a compatible pacing flow measuring device, semi-automatically with a flow chart and an automatic sampler capable of collecting discrete samples, or manually.
2. There are two methods used to collect this type of sample:
 - a) One method collects a constant sample volume per stream flow (e.g., 200 milliliters (ml) sample collected for every 5,000 gallons of stream flow) at time intervals proportional to stream flow. This method provides representative samples of all waste streams when the flow is measured accurately. For this reason, it is used frequently.
 - b) In the other method, the sample is collected by increasing the volume of each aliquot as the flow increases, while

maintaining a constant time interval between the aliquots (e.g., hourly samples are taken with the sample volume being proportional to the flow at the time the sample is taken).

- f. Sequential Composite Sample - Composed of discrete samples taken into individual containers at constant time intervals or constant discharge increments.
 - 1. For example, samples collected every 15 minutes are composited for each hour.
 - 2. The 24-hour composite is made up from the individual one-hour composites.
 - a) Each of the 24 individual samples is manually flow proportioned according to the flow recorded for the hour that the sample represents.
 - b) Each flow proportioned sample is then added to the composite samples.
 - c) The actual compositing of the samples is done by hand and may be done in the field or the laboratory.
 - d) In most cases, compositing in the field is preferable since only one sample container must be cooled, and then transported to and then handled in the laboratory.
 - e) A 24-hour composite is frequently used since an automatic sampler can easily collect the individual samples.
 - 3. A variation of the 24-hour composite is to collect a constant volume of sample taken at constant discharge increments, which are measured with a totalizer. For example, one aliquot is collected for every 10,000 gallons of flow.
 - 4. Sequential sampling is useful to characterize the waste stream

because you can determine the variability of the wastewater constituents over a daily period.

For example, for pretreatment studies you can visually determine when high strength wastes are being discharged to a facility or when heavy solid loads are being discharged during a 24-hour cycle. You can measure different pHs throughout the day. The value of this type of sampling must be weighed against the manpower constraints and sampling goals.

- g. Continuous Composite Sample - Collected continuously from the waste stream. The sample may be a constant volume which is similar to the time composite, or the volume may vary in proportion to the flow rate of the waste stream, in which case the sample is similar to the flow proportional composite.
- h. Areal Composite - A sample composited from individual grab samples collected on an areal or cross-sectional basis. Areal composites shall be made up of equal volumes of grab samples; each grab sample shall be collected in an identical manner. Examples include soil or residual samples from grid system points on a land application site, water samples collected at various depths at the same point or from quarter points in a stream, etc.

4.4.3 General Concerns

- a. The sampler must weigh advantages and disadvantages when choosing between the use of grab or composite sampling methods.
 - 1. While grab sampling allows observation of unusual conditions that may exist during discharge, such as sudden bursts of color or turbidity, this method is labor intensive and impractical when sampling is performed at many locations over extended periods of time.

2. When sampling a large number of locations, the use of automatic samplers is more practical.
 - a) Automatic samplers also help reduce human error, specifically in complex sampling activities, such as flow proportional sampling, and reduce exposure to potentially hazardous environments.
 - b) The primary disadvantage to automatic sampling is the cost of the equipment and maintenance requirements. Many automatic samplers in use today are electronically controlled and must be sent back to the manufacturer when a malfunction occurs.
- b. In order to obtain a representative sample, sampling must be conducted where wastewater flow is adequately mixed. In general these criteria shall be used to evaluate the location:
 1. A sample should be taken in the center of the flow where velocity is highest and there is little possibility of solids settling.
 - a) The sample should be collected at a depth between 40% - 60% of the total depth where the turbulence is maximized. This means that sample collection should be avoided at the water surface or the channel bottom.
 - b) Flow mixing is particularly important for ensuring uniformity.
 2. Sampling personnel should be cautious when collecting samples near a weir because solids tend to collect upstream and floating oil and grease accumulate downstream.
 3. If the sample is not to be tested for volatile organics or will not be affected by stripping of dissolved gases, mechanical stirring may be used or a stream of air may be introduced into the waste stream.
 4. In sampling from wide conduits, cross-sectional sampling should be considered. Dye may be used as an aid in determining the most representative sampling point(s). Note: appropriate Department

personnel should be consulted for the type of dye and acceptable protocols.

5. If manual compositing is employed, the individual sample bottles must be thoroughly mixed before pouring the individual aliquots into the final composite container.
6. If the sample is taken from an effluent tap, allow the tap to run for one - two minutes to allow the settled solids to flush from the line. Reduce the flow to 500 ml/min before collecting the samples.
- c. Sampling and flow measuring are integrally related. The sampler must know the wastewater flow variability before a sampling program can be initiated. Whether to use a flow proportional or time composite sampling scheme depends on the variability of the wastewater flow. If a sampler knows or suspects significant variability in the wastewater flow or knows nothing about the facility, a flow proportional sample should be collected; otherwise a time composite sample would be acceptable.
- d. Prior to sampling, the flow measuring system (primary flow device, totalizer, recorder) should be examined. If the flow measuring system is unacceptable, the sampler may have to install a flow measuring device. If the flow measuring system is acceptable, samples can be collected by the appropriate method.
- e. Fill out the information on the sample container tags and on the field sheets completely and carefully. Improper sample identification results in invalid or unacceptable samples and lost sampling efforts.
- f. Take inordinate care to prevent cross-contaminating samples. Use properly cleaned sampling equipment.

4.4.4 Sample Equipment Requirements

4.4.4.1 Manual Sampling

- a. The types of sampling devices that may be used to collect samples are specified in the next section. Additional discussions are found the protocols for collection grab samples in surface water (section 4.3.3.1).
- b. IN ALL CASES, the selected sampling equipment shall be compatible with the components to be collected and shall comply with the use and construction restrictions specified in Table A-1.
- c. All equipment shall be cleaned using the appropriate protocols specified in Section 3.0. Sample containers shall be cleaned according to Section 6.1 or obtained precleaned from commercial sources.

4.4.4.2 Automatic Samplers

- a. A wide variety of automatic samplers are commercially available (e.g., Sigma, ISCO). Most have the following five interrelated subsystem components:
 1. Sample Intake Subsystem - The sample intake gathers representative samples from the sampling stream.
 - a) The intake is usually the end of a plastic suction tube which should also be resistant to physical damage from large objects in the flow stream. Nonleaching tygon tubing is most often used.
 - b) Teflon tubing shall be used under the conditions specified in 4.4.4.2.b.2. The end of this tubing should be fixed to a piece of conduit or a pole bent to hold the sample port in the waste stream at the correct location to get a representative

sample. The tubing shall be supported in such a way that the incoming sample is not contaminated by either the supporting pole or the method of attachment.

2. Sample Gathering Subsystem - Automatic samplers provide one of three basic gathering methods:
 - a) Mechanical - Mechanical gathering subsystems are usually built into place and include devices such wide/deep channel flow. Because of the mechanical as cups on cables, calibrated scoops, and paddle wheels with cups. Although these systems obstruct the stream flow, they take into account site specific considerations, such as high sampling lift and system employed, these units require periodic maintenance.
 - b) Forced Flow - Forced flow gathering subsystems are often built into place as permanent sampling facilities; thus, like the mechanical gathering subsystems, they may obstruct the stream flow. They also require periodic inspection and maintenance. However, forced flow subsystems have the advantage of being able to sample at great depths. In addition, because this gathering system uses air pressure to transport the sample, it may be ideal for sample collection in potentially explosive environments.
 - c) Suction Lift - The suction lift is the most widely used type of sample gathering subsystem due to its versatility and minimal affect on flow patterns. Suction lifts are limited to 25 vertical feet or less because of internal friction losses and atmospheric pressure. At least 100 ml should be collected each time the pump is actuated.

3. Sample Transport Subsystem - The sample is usually transported from the sample intake to the collection bottle by a plastic tube referred to as the sample transport subsystem. Care should be exercised to avoid sharp bends and twists in the transport line.
4. Sample Storage Subsystem - The sample storage subsystem can accommodate either a single large collection bottle or a number of smaller collection bottles.
 - a) The total sample volume storage capability should be at least 2 gallons (7.6 liters): some samplers have a capacity as great as 5 gallons.
 - b) To thermally preserve the samples, storage subsystems must be large enough to provide space for ice to chill the sample during collection.
 - c) Samples with individual bottles for discrete collection are usually equipped with a cassette which rotates to fill the bottle at the time of sampling.
5. Controls and Power Subsystem
 - a) The control units allow selection of time or flow compositing method, or continuous sampling method. The automatic samplers most widely used have encapsulated solid state controls. This minimizes the effects of unfavorable environments that may be encountered in the field, such as high humidity and corrosiveness. These units are also sealed so that they may be used with minimum risks in potentially explosive environments. In addition, sealed units protect the controls if the sampler is accidentally submerged.
 - b) Samplers operating from a power supply are more reliable than battery operated models; however, field conditions

often prohibit the use of a power supply.

b. Automatic sampling equipment must meet the following requirements:

1. Sampling equipment must be properly cleaned to avoid cross contamination which could result from prior use (see section 3.5 for specific cleaning procedures).
2. If samples for organics (includes all extractable organics, pesticides, and herbicides and TOC) are to be collected, no plastic or non stainless steel parts of the sampler shall come in contact with the water or wastewater stream:
 - a) Teflon tubing shall be used in the transport subsystem.
 - b) A special sampler base and glass containers may also be necessary for sampling organics. Consult the owner's manual.
3. If the preservation requirements for a particular component specify that a sample be thermally preserved, the sampler must be able to keep the samples cool to 4°C during the sampling period. This is accomplished in the field by using ice or refrigeration units in the sampler.
4. The sampler must be able to collect a large enough sample for all parameter analyses. Additionally, split samples may also be necessary.
5. A minimum of 100 ml should be collected each time the sampler is activated, if a peristaltic pump is used.
6. The sampler should provide a lift up to at least 20 feet and the sampler should be adjustable so that volume is not a function of the pumping head.
7. The pumping velocity must be adequate to transport solids and

not allow solids to settle.

8. Pump intake line

- a) The automatic sampler must provide for line purging after each sample is drawn to prevent contamination of subsequent samples.
- b) The minimum intake line inside diameter shall be at least 1/4 inch, which is large enough to lessen chances of clogging but small enough to maintain velocity and to avoid solids settling.

9. Sample transport system

- a) The tubing should be at least 1/4 inch inside diameter to maintain adequate flow and to prevent plugging.
- b) Tubing should be sized so that a velocity of at least two feet per second can be maintained.
- c) Line must be automatically purged after each sample is collected.
- d) An adequate power source should be available to operate the sampler for 48 hours at a 30-minute sampling interval.

10. Sample collection vessels large composite or discrete sample containers, shall be constructed of materials appropriate for the tests to be performed. As a general rule, the vessels shall be made of the same material as those specified for sample containers in section 6.2.3.

c. In addition to the requirements listed in 4.4.4.2.b above, several factors should be considered in selecting automatic sampling equipment. Among these are:

- 1. Convenience of installation and maintenance - Sampling equipment should always be handled carefully and maintained in

accordance with the manufacturer's instructions. Most equipment failures are caused by careless handling and poor maintenance.

2. Equipment security

- a) Security is important when sampling is done as part of an enforcement proceeding.
- b) Manhole locations where battery operated equipment may be installed and the cover replaced will aid in maintaining security.
- c) If sampling equipment must be left unattended, the sampler should be provided with a lock or seal which, if broken or disturbed, would indicate that tampering had occurred.

3. Operation in cold or hot weather

- a) Cold weather - If a sample must be taken during extremely cold days freezing of intake lines may happen. These problems may be handled by using heat tape or placing the sampler inside a thermostatically controlled, electrically heated enclosure. In the absence of special equipment, freezing may be prevented by installing the sampler in a manhole or wet well or by wrapping the sampler with eight or nine inches of insulation and wind protection. Also, the sampler should be positioned well above the effluent stream so that the tubing runs in a taut, straight line to prevent pooling of liquid.
- b) Hot weather - If possible, choose a shaded or even cooled place for the sampler. If not, insulation wrapped around the sampler may help. Painting the sampler white will reflect some heat. Before leaving the site refill the automatic

sampler with ice or check to see that the refrigeration unit is operating. An attempt should be made to pick up the samples near the time the last sample is taken. Samples which are allowed to warm up are questionable, if not useless.

4.4.5 Sample Acquisition

4.4.5.1 Manual Sampling

- a. Manual sampling is used for collecting grab samples for immediate in-situ field analyses. However, it can also be used in lieu of automatic equipment over extended periods of time for composite sampling, especially when it is necessary to observe and/or note unusual waste stream conditions.
- b. Collection using the Sample Container
 1. The actual sample container must always be used for collecting samples for oil and grease, volatile organic compound (VOC), and bacteriological samples.
 2. If possible, manually collected samples should be collected in the actual sample container that will be submitted to the laboratory. This eliminates the possibility of contaminating the sample with an intermediate collection container.
 3. Sample containers containing premeasured amount of preservatives SHALL NOT be used to collect surface water grab samples. Alternative collection procedures listed below must be followed.
 4. Sample collection shall follow the protocols for collecting simple grab samples in surface water (Section 4.3.3.1).
- c. Sampling with an intermediate vessel or container

1. If the sample cannot be collected as described above, an intermediate vessel can be used.
 2. The sample shall be collected following the protocols described for collecting surface water grab samples with an intermediate container or pond sampler and redistributed into appropriate sample container(s).
- d. Samples collected in bailers
1. Bailers may be used if the data requirements do not necessitate a sample from a strictly discrete interval of the water column.
 2. Bailers with an upper and lower check-valve can be lowered through the water column and water will be continually displaced through the bailer until the desired depth is reached, at which point the bailer is retrieved. This technique may not be successful in strong currents.
 3. Specific sampling protocols outlined under mid depth surface water sampling shall be followed.
- e. Samples collected with pumps
1. In some cases it may be best to use a pump, either power or hand operated, to withdraw a sample from the water or wastewater stream.
 2. Protocols for the use of pumps are specified in the surface water sampling and shall be followed when collecting with pumps.
- f. Dedicated equipment may also be used at each sampling station. This will avoid cross contamination between sampling stations. For most parameters (other than trace metals and organics) rinsing the sampling device three times in the effluent stream is sufficient. More stringent requirements must be used for trace pollutants.

4.4.5.2 Automatic Samplers

- a. Automatic samplers may be used when several sites are to be sampled at frequent intervals or when a continuous sample is required.
- b. Conventional Sampling: All composite samplers can be used to collect time composite or flow proportional samples.
 1. In the flow proportional mode, some samplers are activated by a compatible flow meter.
 2. Flow meter operation will not be discussed here. Refer to the operating manuals if you have them.
 3. For older models, flow proportional samples can be collected using a discrete sampler and a flow recorder and manually compositing the individual aliquots in flow proportional amounts.
- c. Installing the Composite Sampler
 1. All new or precleaned tubing (Dow Corning Medical Grade Silastic, or equal, in the pump and either Teflon or Tygon, depending on the parameters of interest, in the sample train) shall be used each time the sampler is installed.
 - a) Cut the proper length of precleaned Teflon or Tygon tubing;
 - b) Rinse deionized water through the sampler and collect an equipment blank;
 - c) Put the collection sieve and tubing in the appropriate sample location in the wastewater stream, using conduit if necessary to hold it in place. Assure that the incoming sample water is not contaminated by the supporting conduit; and
 - d) Program the sampler as per manufacturer's directions and as required in the permit conditions.

2. For a time composite sample, the sampler should be programmed to collect 200 ml at 30-minute intervals or 100 ml at 15-minute intervals into a refrigerated 3-gallon jug. For a 5-gallon compositing jug, the volume should be increased accordingly.
 3. For a flow proportional sample, the sampler should be programmed to collect a minimum of 100 ml for each sample interval, with the interval predetermined based on the flow of the waste stream.
 4. At the end of each 24-hour sampling period, the contents of the compositing jug (sample) should be stirred and siphoned (poured if no visible solids) into the respective containers, followed by immediate preservation, if required.
- d. Automatic Sampler Security - A lock or seal may be placed on the sampler to prevent or detect tampering. However, this does not prevent tampering with the sampler tubing.
 - e. Sample Preservation - Samples shall be preserved for all samples according to 40 CFR Part 136 Table II.
 1. Table II includes allowances for automatic samplers. In addition to the capability of keeping samples cooled with ice or refrigeration, there are 2 considerations to be presented for chemical preservation:
 - a) If separate bottles are used, they may be prepreserved with the appropriate chemical preservative or preserved after sampling has been completed (WITHIN 24 HOURS);
 - b) If the large compositing jug is used, preservation should be completed after sampling has been completed (WITHIN 24 HOURS);

- c) NOTE: If the only parameter of interest is Total Phosphorus, and the project is unrelated to a NPDES permit, then the sample must be chemically preserved (H_2SO_4) but it need not be cooled to $4^{\circ}C$ with wet ice. The acid must be in the container prior to sample collection.

4.5 Groundwater Sampling

4.5.1 Introduction and Scope

This section presents the standard operating procedures that should be employed during field investigations to ensure that representative groundwater samples are collected. Care should be taken so that the sample collected is neither altered nor contaminated by sampling and handling procedures.

The following discussions cover acceptable: equipment choice, equipment construction materials, pre-sampling and in-field decontamination, purging and sampling technique, and proper field Quality Control procedures. Although not a complete discussion of all groundwater sampling procedures, this information has been compiled with the intent of providing the equipment and techniques for situations that are most likely to be encountered.

4.5.2 Purging and Sampling Equipment

4.5.2.1 General Considerations

- a. Purging the monitor well of stagnant water can be performed with various equipment. The choice of equipment will depend on the parameters of interest, the well diameter, the well specific capacity, transmissivity, the water level elevation and other site conditions. As stated earlier, the choice of equipment used for purging must not bias the "representativeness" of the sample collected.

- b. It is recommended that field personnel use pumps to purge monitor wells if at all possible.
- c. Bailers are not recommended for purging monitor wells because frequent lowering and retrieving of the bailer:
 - 1. will introduce atmospheric oxygen which may precipitate metals (e.g. iron) or cause other changes in the chemistry of the formation water (i.e. pH),
 - 2. will result in agitation or volatilization of groundwater which may bias volatile and semi-volatile analyses, and
 - 3. may introduce dirt through scraping the sides of the casing wall.
- d. Though bailers are not recommended for purging, they are acceptable if constructed of the appropriate material and if extreme care is used.
- e. All standing water around the top of the well casing (manhole) shall be removed before opening the well.

4.5.2.2 Pumps

- a. Above-ground Pumps
 - 1. Peristaltic Pump - Peristaltic pumps may be used to purge low volume, low specific capacity wells in which the static water level in the well is no greater than 20-25 feet BLS (Below Land Surface).
 - a) Decreased pumping velocity will be experienced when water levels are deeper than 18'-20'.
 - b) It also may be used to sample wells for limited parameter groups. These parameter groups will be dependent upon tubing materials and arrangements. It is the preferred method of collecting filtered groundwater samples for

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metals. See Table A-1 for details on the restrictions for this pump, including choice of tubing (i.e. Teflon, HDPE, Tygon).

2. Centrifugal Pump - Centrifugal pumps can be utilized to purge 2 inch and larger internal diameter wells that have moderate specific capacities from 2 - 10 gpm (gallons per minute) and have a static water level greater than 20 feet BLS.
 - a) The pump may also be attached directly to 3/4" well point casing and used to purge (care must be taken so that purged water does not fall back into the well casing).
 - b) Sampling gloves shall be worn and discarded after positioning the pump. Hands should be washed and new gloves shall be put on prior to sampling.
 - c) See Table A-1 for compatibility restrictions related to choice of tubing and allowable parameter groups.

b. Submersible Pumps

1. Electric Submersible Pumps - Submersible pumps (e.g. Grundfos, Goulds, Jacuzzi) can be utilized for purging 4 inch or greater diameter monitor wells. Some submersible pumps can be utilized in 2 inch wells (e.g. Fultz and Grundfos). These pumps can be used in wells that have moderate to high specific capacity and cannot be purged using an above-ground pump because of the lower static water level elevation (>20'-25' BLS).
 - a) The pump must be constructed of stainless steel (and/or Teflon) material and the delivery hose shall be constructed of appropriate material depending upon the analytes of interest.

- b) It may be fitted with inert stainless steel or Teflon tubing between the pump and "other non-inert tubing" to be able to purge wells that will be sampled for trace organics.
- 2. Bladder Pumps - Positive-displacement bladder pumps (no-gas contact) can be utilized for purging wells where the water table is greater than 25 feet and an above-ground pump cannot be used. These pumps are used in wells with low to moderate capacity since pumping rates are not as high as the electric submersibles or the gas-contact "purge pump" described below. Maximum pumping rates are approximately 0.5 - 1.5 gallons per minute depending upon the location of the pump (BLS).
 - a) The bladder pump system is composed of three major components: the pump, the compressed air and water discharge tubing, and the controller/compressor.
 - b) The pump consists of a bladder and an exterior casing or pump body that surrounds the bladder. These two parts can be composed of various materials, usually combinations of PVC, Teflon, and stainless steel.
 - c) The construction material of the pump body, pump bladder, and the discharge tubing will define the parameters that can be purged and sampled with this system.
 - d) If the pump is not permanently installed in the monitor well and if it is to be used to purge and/or sample for all parameters (including VOCs), the pump, bladder and tubing must be constructed of stainless steel and Teflon.
 - e) Permanently installed pumps have a PVC pump body as long as the pump remains in contact with the formation water. If VOCs and/or extractable organics are of interest, the

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bladder and the delivery tubing shall be constructed of teflon.

3. Bladderless Purge Pumps - These pumps are identical to the bladder pumps described above except they do not have an internal bladder. The air controller/compressor is used to force water from within the pump body up the discharge tubing. By not having the (Teflon) bladder fill by head pressure, pumping rates are much higher (> 4 gpm).

- a) This pump can only be used for purging.
- b) Additionally, operation of this pump cannot result in purge water escaping back into the well. Proper operation and maintenance of the check valve must be ensured. Release of aerated purge water into the water column is not acceptable.

c. Hand Pumps

1. Hand pumps (e.g. Brainard-Kilman 'B-K Pump') are manual pumps that should be utilized for purging 2- or 4-inch diameter monitor wells in which the static water level is too deep for use of a centrifugal or peristaltic pump.
 - a) The B-K hand pump and the associated riser pipes are constructed of PVC and shall be used to purge when only inorganic constituents are of interest unless the restrictions specified in Table A-1 are followed.
 - b) The lower most section of the B-K pump is equipped with a foot valve to prevent back flow of purge water.
 - c) After purging has been completed, the B-K pump should be completely disassembled and decontaminated.
 - d) Please see Table A-1 for details on the use of this pump.

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4.5.2.3 Bailers

- a. As stated above, the use of bailers is not recommended for purging.
- b. Bailers shall be composed of material compatible with the analytes of interest. See Table A-1 for restrictions
 1. Bailers constructed of stainless steel and Teflon may be used to sample any and all parameters.
 2. Bailers constructed of high density (rigid) polyethylene (HDPE) materials may be used to sample monitor wells for inorganics and free-product only.
 3. When sampling grossly contaminated tanks or other facilities, disposable polyethylene (or other material) bailers should be utilized (it may be difficult to decontaminate such grossly contaminated bailers and as such they may have to be discarded).
- c. The bailer must be handled carefully so as not to contaminate it prior to use.
- d. They shall be scrupulously cleaned, including all check valves.

4.5.2.4 Lanyards

- a. Lanyard may be disposable (braided or monofilament nylon or reusable (stainless steel or teflon-coated).
- b. A disposable lanyard must be changed for each monitor well, but the same lanyard may be used for purging (if performed) and sampling operations without decontamination between purging and sampling operations.
- c. Reusable lanyards shall be decontaminated between monitor wells but do not require cleaning between purging and sampling operations.

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4.5.3 Water Level and Purge Volume Determination

Prior to sampling, an adequate amount of stagnant well water in the well must be removed in order to sample representative formation water. Inspect the exterior protective casing monitor well for damage and document accordingly.

a. Water Level Measurements

1. In order to calculate the purge volume, the water level is determined by using an electronic probe, chalked tape, etc.
2. The depth below land surface shall always be recorded to the nearest 0.1 foot from the same reference or survey mark on the well casing.
3. Measurements using an electronic probe shall follow the manufacturer's instructions. Since false reading may be obtained if the sensor contacts the well casing, multiple readings shall be taken to ensure accuracy.
4. Decontaminate all measuring devices immediately after use and prior to next measurement.

b. Water Column Determination

1. The total water column is obtained by subtracting the depth to the top of the water column from the total depth of the well.
2. Total depth of well is dependent upon the well construction. Some wells may be drilled in areas of sinkhole or karst formations. In cases where there may be an open borehole below the cased portion, an attempt should be made to find the total borehole depth.

c. Well Water Volume

The length of the water column is then converted to volume of water that is present in the well:

1. 2 inch casing:

$$V = 0.17 \times h$$

Where: V = volume in gallons

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h = height of the water column in feet

2. 4 inch casing:

$$V = 0.66 \times h$$

Where: V = volume in gallons

h = height of the water column in feet

3. For other casing sizes, calculate using the following:

$$V = (0.041)d \times d \times h$$

Where: V = volume in gallons

d = well diameter in inches

h = the height of the water column in feet

or:

$$V = \pi \times r \times h(0.001)$$

Where: V = volume in liters

$\pi = 3.14159$ (pi)

r = radius in centimeters

h = height of water column in centimeters

- d. Record all measurements in the field records.

4.5.4 Detection And Sampling Of Immiscible Layers

4.5.4.1 Scope/Applications

This procedure covers the methods used to detect and sample immiscible layers. If a facility has a release containing chemical constituents that are insoluble and that have special gravities either greater or less than that of water, then that facility's sampling and analysis plan must address immiscible layers.

4.5.4.2 Summary of Method

The presence of organic vapors should be determined by the use of either a photoionization analyzer or a organic vapor analyzer. The presence of organic vapor may indicate a floating layer on the surface of the groundwater. An interface probe is used to determine the existence of a floating layer. A bailer is then used to sample the floating layer. If a sinker exists a double valve bailer is lowered to the bottom of the well in order to sample the layer.

4.5.4.3 Comments

Sampling of the immiscible layer must take place prior to purging. If the floating layer is greater than 2 feet thick then a bottom valve bailer should be used. If the floating layer is less than 2 feet thick but less than 25 feet from the surface then a peristaltic pump should be used. If the floating layer is less than 2 feet thick but more than 25 feet from the surface then an open top closed bottom bailer should be used. A double valve bailer should be used for immiscible layers that are sinkers. Detection and sampling of immiscible layers must be done prior to purging.

4.5.4.4 Procedures

- a. Sample the air in the well head for organic vapors using either a photoionization analyzer or an organic vapor analyzer, and record measurements.
- b. Determine the static liquid level using a water level indicator and record the depth in the log book.
- c. Lower an interface probe into the well to determine the existence of any immiscible layer(s), light and/or dense.

- d. Remove clean bailer from protective covering, attach cord, type of bailer used will be determined by immiscible layer being sampled.
(See comments)
- e. Lower bailer slowly to the interval from which the sample is to be collected. if the sample interval is a floating layer only a few inches thick then the open top bailer should be lowered to the top of the immiscible layer and an additional half thickness of the immiscible layer.
- f. Raise bailer to surface, feeding cord into container, reel or onto clean plastic sheeting. Do not allow bailer cord to contact ground.
- g. Remove the cap from the sample bottle, and tilt the bottle slightly.
- h. Pour the sample slowly down the inside of the sample bottle. Avoid splashing of the sample. Assure that any suspended matter in the sample is transferred quantitatively to the sample bottle.
- i. Leave adequate air space in the bottle to allow for expansion, except for VOA flasks.
- j. Label the bottle carefully and clearly. Enter all information accurately, and check to be sure it is legible.
- k. Samples will be placed in containers defined according to the need, and then, when appropriate, packed with ice or ice packs in coolers as soon as practical.

4.5.5 Well Purging Techniques

To ensure a representative groundwater sample from a monitor well it is essential that the well be purged prior to sampling. Stagnant water in a well casing may undergo a variety chemical changes due to alterations in the redox potential, pH and leaching of organic compounds from the casing.

- a. Equipment selection shall comply with construction and configuration

requirements specified in Table A-1.

- b. A clean protective covering may be placed around the wellhead during purging activities. If this protective covering becomes soiled, ripped, etc. it must be replaced prior to sampling.
- c. The total amount of water must be recorded. Therefore, the volume must be measured during the purged operation. The amount may be determined by:
 - 1. Collecting the water in a graduated container (i.e. bucket); or
 - 2. Calculating volume based on pumping rate. Note: the pumping rate may not be constant; take this into account.
- d. Record the time that actual purging begins in the field records.
- e. Purging is considered complete if any one of these criteria are satisfied:
 - 1. three well volumes and subsequent stabilization of field parameters
 - a) Stabilization of field parameters is defined as "consecutive readings within 5% taken at least five minutes apart".
 - b) Even if field parameters have not stabilized after 5 well volumes, purging is considered complete and sampling can begin.
 - 2. five well volumes (field parameters not monitored);
 - 3. at least one fully dry purge.
 - a) It has been suggested that one dry purge may not be adequate and a second dry purge may be necessary.
- f. Except for "low recovery" wells, all wells shall be sampled within 6 hours of purging.
 - 1. "Low recovery" wells or wells that have been purged complete dry may be sampled as soon as sufficient sample matrix is available or up to 10 hours after purging.
 - 2. Wells that have not recovered sufficiently within 10 hours of purging should not be sampled.

g. Lanyards

1. All lanyards must be securely fastened to downhole equipment (bailers, pumps, etc.).
2. Equipment construction and decontamination shall follow guidelines discussed in Purging and Sampling Equipment above.
3. Bailer lanyards must be handled such that they do not touch the ground surface.

h. Low Hydraulic Conductivity Monitor Wells (i.e. wells that can be purged dry)

1. The most straightforward method for removing all of the stagnant water in wells screened in low hydraulic conductivity formations is to install the pump in the screen area and pump the well dry.
2. Although this procedure may allow the atmosphere to contact the area of the aquifer immediately surrounding the well screen, it is the best way to ensure that all the stagnant water has been removed.
3. If required, allow the well to recover and purge the well a second time.

i. High Hydraulic Conductivity Wells (i.e. wells that cannot be purged dry)

1. For those wells with dedicated purging/sampling systems where the pump is set in the screened area of the well, complete evacuation of the stagnant water column may not be possible.
2. The degree to which the stagnant water column can be replaced by fresh aquifer water will be a function of the aquifer transmissivity and the number of well volumes pumped.

j. In general, when nondedicated pumps that are used for purging, the purging process should be done with the pump as near to the top of the water column as possible to ensure that no stagnant water remains in the well above the screen after purging.

k. Peristaltic Pump - One end of a length of new or pre-cleaned tubing shall

be attached to the pumphead flexible hose and the other end immersed no deeper than one foot into the water column.

1. Centrifugal Pumps

1. To minimize cross contamination while purging, fuel driven centrifugal pumps must be placed at least 10 feet from the well head and downwind of the well.
2. Sampling gloves shall be worn and discarded after positioning the pump. Hands should be washed and new gloves shall be put on prior to sampling.
3. The length of suction hose should be situated such that the pump will be withdrawing water from the top of the column.
4. If the pump rate exceeds the recovery rate of the well then the hose should be lowered into the well as needed to accommodate the drawdown.
5. The suction hose must have a footvalve installed to prevent purge water from re-entering the well.

m. Electric Submersible Pumps

1. The pump should be set as near the top of the water column as possible to ensure that all stagnant water in the casing is removed and to minimize the contact area of the delivery hose with water column.
2. If the pump rate exceeds the specific capacity of the well then the pump must be lowered to accommodate the drawdown.
3. If the pump has a controller, the flow rate may be adjusted to be equal (or nearly) to the well's pumping capacity.

n. Bladder Pumps

1. This equipment shall be operated strictly according to the owners/operators manual or sample integrity and representativeness may be suspect.

2. After determining water level, position the controller/compressor away from the well and downwind (if fuel powered compressor or generator).
 3. Attach tubing and lower the pump to a depth of 3 - 5 feet below the surface of the water.
 4. If the pump is positioned too deep all of the stagnant water may not be purged. If positioned too shallow purging time will be slower as the bladder fills under standing head pressure.
 5. Adjust the pump position to follow the water level drawdown, if necessary.
 6. It may be necessary to adjust the purging rate so that it is equivalent to the drawdown rate.
 7. Discharge must be directed into graduated bucket or equivalent to determine the number of well volumes.
- o. BK Hand Pump
1. For the B-K Pump, the intake is lowered to the top of the water column by attaching additional 5-foot sections onto the pump.
 2. By changing the stroke of the actuating rod the pumping rate can be made compatible with the well-specific yield.
- p. Bailers
1. The bailer must be handled carefully so as not to contaminate it prior to use.
 2. The bailer must be lowered through the well and into the formation water slowly. Allowing the bailer to drop into the formation water with a splash is not acceptable.
 3. The bailer should be used to pull purge water from the top of the water column so that fresh aquifer water can be pulled in through the screen. This technique shall be performed until the requisite number of well volumes have been evacuated.

- q. All purging activities shall be documented in the field notes.

4.5.6 Groundwater Sampling Techniques

4.5.6.1 Equipment Considerations

- a. Some pumps may be used for sampling groundwater. All notes and restrictions as defined in Table A-1 and discussed in Purging and Sampling Equipment shall be followed when using pumps to collect samples.
- b. Other than the actual sampling device, intermediate vessels should not be used during the sample collection process. This is especially true of any compound where loss of sample is a problem (O&G, TRPH and VOCs). For all trace compounds, the sample should come in contact with as few surfaces or vessels as possible since excessive handling can result in contamination or sample loss.
- c. Dedicated Sampling Equipment
 1. The use of dedicated equipment is recommended since it significantly reduces the chance of cross-contamination.
 2. Dedicated is defined as equipment that is to be used solely for one location for the life of that equipment (permanently mounted pump or permanently dedicated bailer).
 3. All material construction and restrictions from Table A-1 also apply to dedicated equipment. Equipment should be purchased with the most sensitive analyte of interest in mind.
 4. Cleaning/Decontamination
 - a) Dedicated pumps shall be cleaned prior to installation. They need not be cleaned prior to each use but should be cleaned when they are withdrawn for repair or servicing.
 - b) Any permanently mounted tubing need not be cleaned.

- c) Any replaceable or temporary tubing shall be cleaned as specified in Section 3.7.
- d) Equipment blanks on dedicated pumps shall be required when the tubing is cleaned or replaced and shall be collected through that portion of the tubing that is accessible.
- e) Dedicated bailers, if stored in the well, must be suspended above the water column and completely decontaminated between sampling events.
 - 1) After sampling is complete, they shall be rinsed with tap water and/or analyte-free water, wrapped to prevent contamination, and stored on- or off-site until the next sampling event.
 - 2) The sampling equipment shall be decontaminated prior to on-site arrival UNLESS the equipment is stored on-site. In the latter case, the dedicated bailer shall be fully decontaminated prior to on-site use.
 - 3) A precleaned equipment blank shall be collected prior to reintroducing the cleaned bailer into the water column.

4.5.6.2 Sampling with Bailer

- a. When a bailer is used for sampling, the integrity of the sample collected is highly dependent upon the sampler's skill and familiarity with proper sampling techniques.
- b. It is recommended that for a particular site only two persons perform sampling to minimize personnel handling variation.
- c. Just prior to sampling, several bailer amounts of sample groundwater shall be collected to rinse the bailer.
 - 1. Discard the water appropriately (see Waste Disposal).

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2. This should not be done if the analytes of interest include Oil & Grease, TRPH, etc. As stated earlier, intermediate vessels or sampling equipment are never rinsed if these compounds are to be sampled.
- d. All collection activities shall be done carefully so as to not stir up any sediments.
- e. The following procedure describes general bailing techniques:
 1. Field personnel should wear protective gloves.
 2. Attach a fresh length of monofilament or braided nylon line to the bailer. Alternately, a precleaned permanent lanyard may be used.
 3. The bailer or lanyard must not be allowed to touch the ground during purging or sampling.
 4. Lower the bailer slowly and gently into contact with the water so that agitation of the water column is minimized.
 5. Attempt to sample from the same depth in the well each time, preferably within or just above the screened zone of the well.
 6. Do not allow the bailer to touch the bottom of the well so that bottom sediment is incorporated into the sample.
 7. Retrieve the bailer smoothly. Collecting the lanyard between the thumbs of each hand seems to be the preferred method.
 8. Discard the first few inches of water in the bailer and fill the appropriate sample bottles so that a minimum of turbulence is created to avoid aeration.
 9. Discard the last few inches of water in the bailer.
 10. Add preservatives (if necessary), check the pH of all pH-adjusted samples (except VOCs).
 11. Attach and/or complete the sample container labels, record

information in field notes, place samples on wet ice (if required) and protect all samples from sun.

f. Disposable Bailers

1. Disposable bailers of the appropriate construction material are available. High density polyethylene (HDPE) bailers are acceptable for all inorganic parameters (and free product thickness).
2. Teflon bailers are also available as a disposable for use where organics are of concern.
3. Precleaned equipment blanks are required for disposable equipment.

4.5.6.3 Sampling with Pumps

As a general rule, pumps shall not be used to collect samples if organics are of interest. There are two exceptions: 1) use of the peristaltic pump with a trap for EXTRACTABLE organics; and 2) use of an all Teflon and stainless steel bladder pump for all organics.

a. Peristaltic Pump

1. Organics

- a) The container shall be a glass or teflon bottle. The sample container is recommended, however, if an intermediate vessel is used, it shall be decontaminated between wells per Section 3.4.1.
- b) All equipment that contacts the groundwater BEFORE the sample container shall be of Teflon, stainless steel or glass construction, including the transport tubing to and from the sample container, the interior liner of the container cap and all fittings.

- c) Connect the outflow tubing from the container to the influent side of the peristaltic pump.
- d) Turn the pump on and allow the container to fill approximately 1/4 full.
- e) Turn the pump off, disconnect the container, rinse the bottle and discard the contents.
- f) Repeat the process a second time.
- g) Turn pump on to fill the container.
- h) If an intermediate container is used, distribute the sample into appropriate containers.
- i) If the sample container is used, discard a small portion of the sample, to allow an air space.
- j) Preserve (if required), label and complete field notes.

2. Inorganics

- a) Inorganic samples may be collected from the effluent tubing, and there are few restrictions on tubing type.
- b) If samples are collected from the pump, all tubing (including the tubing in the head) shall be changed between wells.

b. Bladder Pump

- 1. The flow rate shall be reduced after purging to a smooth, even flow.
- 2. When sampling for VOCs, the flow rate must be reduced to 500 ml/minute (approx. 0.1 gallon/min).

c. Other pump types

- 1. Sampling for INORGANICS ONLY may be conducted with most other pump types (see Table A-1).
- 2. The flow rate during sample collection shall be a smooth even flow.

3. All tubing and the pump shall be decontaminated between wells.

4.5.6.4 Sampling Dissolved Metals

- a. In order to collect a "representative" sample for the purpose of monitoring compliance with groundwater standards for metals, it may be necessary to field filter a sample prior to preservation.
- b. In situations where the static level in the well allows use of a peristaltic pump, the groundwater sample shall be pumped directly from the well through an in-line filter.
 1. A disposable, high capacity, 1.0 um (metals only) filter is an acceptable filter for most applications. See Table A-1 for allowable equipment setups.
 2. In field use, the filter must first be flushed with 30 - 50 mls of deionized water or an inert gas to remove atmospheric oxygen.
 3. The filter must be inserted on the high pressure side (i.e. on the delivery side) of the peristaltic pump. VACUUM FILTRATION IS NOT ACCEPTABLE.
 4. The sample delivery tube must be long enough (greater than 2 feet) such that back-diffusion of oxygen to the filter is negligible.
 5. New or precleaned silastic tubing shall be installed in the pump at each monitor well.
- c. In situations where the static water level in the well is too deep for a peristaltic pump to be used directly, there are several alternatives:
 1. Groundwater may be sampled with an appropriately constructed bailer. The intake tube of the peristaltic pump is inserted into the full bailer and water pumped through a filter as described above.

2. Any submersible pump of appropriate construction for which the flow rate can be adjusted may be used for water levels below 20'-25'.
 3. Pressurized HDPE and Teflon bailers may also be used.
 4. See the specific section concerning field filtration in Table A-1 for all acceptable alternatives.
- d. It is important that this operation is carried out as rapidly as possible and in such a way that sample agitation and exposure to atmospheric oxygen is minimized. It is for this reason that pouring the sample into any intermediate vessel for subsequent filtration IS NOT allowed. This includes barrel or syringe filters. Once the sample is collected into a sample container, preservation and pH checks should be completed.

4.6 Wells with In-Place Plumbing

Wells with in-place plumbing are generally encountered at wellfields, industrial facilities and private residences. See separate discussions below on sampling potable water wells.

4.6.1 Purging

- a. The volume to be purged depends on several factors: the depth and diameter of the well, whether the pumps are running continuously or intermittently, how close to the source the sample can be collected, and the presence of any storage/pressure tanks between the sampling point and the pump.
- b. If storage/pressure tanks are present, an adequate volume must be purged to totally exchange the volume of water in the tank.
- c. Continuously Running Pumps

1. If the pump runs continuously and the sample can be collected prior to a storage/pressure tank, no purging is required, other than opening a valve and allowing it to flush at maximum velocity for at least 15 minutes.
 2. If the pump runs continuously, and a storage/pressure tank is located ahead of the sample location, the purge must include the entire storage volume to ensure that a sample representative of the groundwater will be collected.
- d. Intermittently Running Pumps
1. If the pump runs intermittently it is necessary to determine the volume to be purged, including storage pressure tanks that are located ahead of the sampling location.
 2. The pump should then run continuously until the required volume has been purged.
 3. When the well depth or diameter is unknown (as is frequently the case with in-place plumbing) purging should be carried out by pumping the well for 15 minutes and until the pH, specific conductance and temperature stabilize.
 - a) In practice, stable sample chemistry is indicated when the purging parameter values remain within 5% over two successive samples taken at least 5 minutes apart.

4.6.2 Sampling

All samples must be collected from the closest spigot to the well head, with all screens or aerators removed, and with the flow rate reduced to no more than 500 ml/min.

4.7 Temporary Well Points

Temporary well points include those drilled with augers as well as those pushed with "direct push" or DPT devices. These types of wells are not permanently installed.

4.7.1 Use

- a. Temporary well points may be used for preliminary investigations and as a screening tool.
- b. If these wells are used to provide formal data, these restrictions apply:
 1. Use precleaned equipment as described in Table A-1;
 2. Well must be purged of 3-5 well volumes (or dry);
 3. Sampling with a peristaltic pump
 - a) Extractable organics shall be collected via an all-Teflon and -glass organic trap configuration;
 - b) VOCs shall not be collected through a pump, but the Teflon pump tubing is allowed to fill via ambient pressure, capped with stopper or gloved finger, carefully withdrawn from the well, and drained into appropriate vials.
 - c) Refer to protocols listed in 4.5.5 and 4.5.6 for specific information on sampling and configuration.
 4. Sampling with bailers
 - a) In some cases, sampling may be accomplished with a 3/4" bailer.
 - b) All equipment construction restrictions shall be followed.
 - c) Refer to bailer sampling protocols in section 4.5.6.

4.8 Bioassay Sampling

When collecting samples for bioassays, the sampling protocols outlined in Section 4.3 (Surface Water) and 4.4 (Wastewater) shall be followed.

The holding time for bioassay samples is 72 hours.

5.0 SOLID MATRIX SAMPLING PROCEDURES

This section is concerned with grab and (areal or depth) composite samples from solid matrix (soil, sediment and waste piles). Since similar procedures and equipment exist for soils and sediments, a general description of sample handling will be discussed.

5.1 General Concerns

- a. Sampling equipment shall be selected based on the type of sample to be collected and the parameters of interest. See Table A-1 for specific requirements.
- b. All equipment shall be decontaminated according to specified protocols in Section 3.0.
- c. All general sampling concerns outlined in this document shall be followed.
- d. Sample container and holding time requirements listed in Section 6.2.3 shall be followed. The sample containers shall be cleaned or obtained according to protocols listed in Section 6.1.1.

5.2 Sample Handling Protocols after Sample Acquisition

General sample handling will fall into 3 main categories; surface, shallow subsurface, and deep subsurface. Each of the three categories will be discussed in general. Once the sample is acquired, the handling procedures are very similar and are described below.

- a. Select the appropriate precleaned sampling device and procure the sample from the desired depth. If using liners to transport the sample to the lab.
- b. Select the required sample container for the parameter group.
- c. Split spoons and Shelby Tubes
 1. Breakdown the sampler (split spoon, Shelby tube). This should be done with the appropriate tools.
 2. At this time, any portion of the sample that has been disturbed shall be identified, removed with a stainless steel spatula and discarded.
 3. Slice the sample using a clean, decontaminated stainless steel spatula from the

center portion of the corer, split spoon or bucket auger head.

4. For VOC analyses, immediately transfer the sliced portion to a suitable container (the container must be equipped with a teflon-lined septum seal).
 - a) Carefully fill the vial (or wide-mouth container) with sample.
 - b) Tamp the sample into the vial with a SS, glass, or Teflon rod to reduce headspace.
 - c) Add sample and tamp down until no headspace exists.
 - d) After cleaning exterior and rim of vial as described below, cap container (with teflon side facing sample) tightly, label and place on wet ice immediately.
 5. For other analyses, slice sufficient amount of sample from the center portion of the sampling device and transfer it to a tray of appropriate construction (note restrictions on use in Table A-1).
- d. Bucket Auger, Dredge or Corer
1. Remove the sample from the sampler (bucket auger, dredge, corer) with appropriate (stainless steel, teflon, etc.) tools and place in a stainless steel, glass or aluminum foil-lined tray (note restrictions on use in Table A-1).
 2. Remove any portion of the sample that has been disturbed with a stainless steel spatula and discarded.
 3. If VOCs are required, fill an appropriate container with aliquots that have been taken from selected areas of the entire sample. Proceed as described in 5.2.c.4 above.
- e. Sample Mixing
1. VOCs shall be collected as discussed above before the sample is mixed.
 2. The sample in the tray shall be homogenized thoroughly:
 - a) Appropriate tools shall be used to mix the sample.
 - b) Homogenize by alternately mixing, dividing, and remixing the sample.
 3. After thorough mixing, transfer the sample to the appropriate sample container(s) leaving minimal headspace.

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- f. Clean the outside of the sample container to remove excess soil.
- g. The container rim should also be cleaned of soil and sand particles so that the lid can be sealed. An improperly sealed container may allow cross contamination from ice melt or petroleum fumes.
- h. Affix sample label, seal (if applicable), and complete the chain-of-custody forms.
- i. Place the sample containers in a clean, plastic sample bag and preserve by placing in wet ice.
- j. Liners
 - 1. If properly used, liners may be inserted into the sampler and used as the actual sample container.
 - 2. Be aware that SW-846 has mandated that all solid samples must be transported in containers that have screw tops. This also means that all container and lid requirements are still in effect.
 - a) For inorganic samples, ends of the liner must be covered with polyethylene, Teflon, or aluminum foil sheeting. The sheeting should be secured by placing an end cap over the sheeting.
 - b) For organic samples, the sheeting must be Teflon or aluminum foil.
 - c) With any sample containerized this way, specific instructions must be sent with the sample so that the laboratory will know how to handle the sample. All non-volatile samples must be homogenized by the laboratory prior to analyses. Also, any disturbed portions of the sample should be discarded prior to mixing.

5.3 Composite Soil Samples

The following is not a complete discussion regarding development of a sample compositing scheme nor all available sampling protocols. When a large site area is to be investigated for contamination, it is sometimes advantageous to composite soil or sediment samples and thus minimize the number of samples to be analyzed.

- a. Sample aliquots (of identical size) to be composited shall be placed in a tray of suitable

materials (see Table A-1) and thoroughly mixed with a cleaned spoon, spoonula or spatula of suitable materials (see Table A-1). The sample shall be thoroughly blended by mixing, and dividing into sections. Each section shall then be mixed separately. Recombine all mixed sections and mix thoroughly. Repeat sectioning and mixing process to ensure proper homogenization.

- b. The origin and size of each (sub)sample or aliquot that is used to make the composite shall be documented in the field notebook along with the other important sampling details.
 1. Although the size of these subsamples is important and should be documented, it is critical that these subsamples be of equivalent size, so that the composite sample is not biased by unequal aliquoting.
 2. There is no level of accuracy here; it is dependent upon the size of the aliquots.
 3. Aliquoting should be done in a systematic manner.
- c. Clean the outside of the sample container to remove excess soil, affix label, seal (if required), and complete the laboratory transmittal forms.

5.4 Soil Sampling

5.4.1 Surface Soil Sampling - ground surface to 6 inches below ground surface

- a. Leaves, grass and surface debris shall be removed from the area to be sampled using a clean stainless steel spoon or shovel.
- b. Surface soil samples can then be collected using a precleaned stainless steel scoop or spoon.

5.4.2 Shallow Subsurface Soil Sampling

- a. Shallow subsurface samples may be collected by digging a hole or trench to the required depth with a stainless steel shovel.
- b. Some situations may require a trench or pit to be dug with a backhoe. Depending upon the equipment available at the site or the soil type to be

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penetrated, this option is acceptable.

1. In these situations, the trench is first dug to the appropriate depth and then the sample is exposed by using one precleaned spoon, spatula, or equivalent to clean away the soil that came in contact with the backhoe bucket and a second precleaned spoon to actually collect the sample.
- c. Alternatively, shallow subsurface soil samples may be collected with 2-4 inch stainless steel bucket auger which would minimize the soil to be removed in order to reach the desired depth. Using this method, a sampling depth of up to 15 feet may be obtained.
 1. The bucket auger consists of a stainless steel cylinder with flush welded stainless steel cutting edges. The cutting edges are hardened surfaces, heat treated and sharpened.
 2. A soil sample is obtained by pushing and rotating the auger into the soil until the bucket is filled.
 3. The sample can be removed (with some difficulty) from the bucket by pushing or scraping with an appropriate precleaned stainless steel tool.
 4. This auger method is useful for obtaining large samples of unconsolidated sediment.
 5. The device is supplied with 3 foot extension rods.
 6. Addition of a sleeve may allow an undisturbed soil sample to be obtained.
 - a) The device consists of a standard auger head with a removable non-contaminating sleeve which is inserted into the auger barrel.
 - b) Either a clear butyl acrylate (CAB) plastic sleeve (for inorganic samples) or stainless steel (for organic samples) may be utilized.
 - c) The soil sample is obtained in the normal manner by pushing and rotating the auger into the soil. In this case it is the sleeve which fills with soil. After auger retrieval, the sleeve, which is readily removed from the auger, is capped.

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7. If the auger hole is prone to collapse, due to low cohesion in some soils, a temporary rigid PVC casing should be inserted into the hole. The casing prevents hole collapse and minimizes cross-contamination between soil zones as the auger is advanced.
 - a) Upon sample collection, the temporary casing (if used) must be removed and the hole filled with the excavated soil.

5.4.3 Deeper Subsurface Soil Sampling

- a. A drill rig is normally required if soil samples are taken from boreholes greater than 15 feet BLS (below land surface). There are a number of sampling devices used in conjunction with the drill rig for retrieving the samples; Shelby tubes, split spoon samplers and standard core barrels.
- b. Shelby Tube Sampler
 1. The Shelby tube sampler is used to sample unconsolidated soils and consists of a stainless steel tube approximately 30 inches long and 2 inches, or larger, in diameter.
 2. One end of the tube has edges beveled into a cutting edge. The other end can be mounted to an adapter which allows attachment to the drill rig assembly.
 3. After drilling to the required depth with an auger or rotary drill bit, a soil sample is obtained through the auger or directly in the borehole.
 4. The Shelby tube is pushed into the soil using the drill rig's hydraulic ram or manually with a sledge hammer.
 5. When the tube is retrieved, the soil sample taken from the center and away from the sides, can be transferred into the appropriate container (for VOCs) and/or mixed using a stainless steel spoon handle or spatula when other parameters are of interest.
- c. Split Spoon Sampler

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1. A split spoon sampler, useful for sampling unconsolidated soils, consists of two carbon steel half cylinders (spoons) that fit together to form a tube approximately 2 feet in length and 2 inches in diameter.
 2. The cylindrical arrangement is maintained by a retaining head and bit rings that screw on at either end of the split spoon.
 3. The bit ring has beveled edges to facilitate sampling as the split spoon is forced into the ground.
 4. As with the Shelby tube, either the weight of the drill stem and rods or a mechanical hammer is used to advance the sampler.
 5. A catcher device is inserted in the head ring to prevent loss of unconsolidated sample during recovery.
 6. After retrieving the split spoons, the soils can be withdrawn by unscrewing the bit and head rings and splitting the barrel.
 7. The top 2 to 3 inches of the sample will be normally disturbed and should be discarded.
 8. A cleaned stainless steel spatula is used to collect a subsample for VOCs and/or transfer the contents into an appropriate tray for mixing and containerizing.
- d. Standard Core Barrel
1. A standard core barrel is utilized when consolidated samples (such as limestone or dolomite) are to be sampled.
 2. The core barrel is carbon steel cylinder approximately 3 feet long and 2 inches in diameter.
 3. The barrel has a removable head ring with small embedded diamonds which allow the device to cut through rock or consolidated soils as the drill rods are rotated.
 4. The sample core can be retrieved by unscrewing the head ring and sliding the sample into the container.

5.5 Sediment Sampling

5.5.1 General Overview

- a. Sediment samples are taken from material underlying streams/rivers, lagoons, ponds/lakes, and estuaries.
- b. The actual sampling location is dependent upon project scope.
- c. Sediment samples may be taken as an adjunct to surface water samples.
- d. They may be taken as a compositing series to define water or sediment quality in a system.
- e. They may be taken above and below an outfall to document degradation.
- f. Similarly, if stressed shore vegetation or visible surface water contamination is evident, sediment samples may be taken.
- g. Decisions for sample location will not be discussed in this document.
- h. All surface water samples shall be taken prior to any sediment samples.

5.5.2 Sample Collection Protocols

- a. Sediment samples are taken via three groups of equipment: scoops; corers and dredges.
- b. Soil sampling equipment is generally not applicable to sediments because of low cohesion of sample.
- c. Sample location (edge or middle of lagoon), depth of water and sediment, sediment grain size (fineness), water velocity, and analytes of interest all must be considered when choosing equipment.
- d. Stainless steel equipment shall be used if trace contaminants are to be sampled.
- e. Dredges must be used for hard or rocky substrates. They are heavy enough to use in high velocity streams.
- f. Coring device may be used for softer substrates. Coring devices must be used in soft substrate if the fine particles are to be included. Coring devices should be used in quiescent waters.

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5.5.2.1 Scoops

- a. Scooping is generally most useful around the margin or shore of the water body.
- b. Stainless steel spoons or grain scoops work very well. The scoops can be attached to an extendible pole for obtaining samples several feet from shore or boat.
- c. The sampler may also wade into the water body to obtain a scooped sample.
- d. The sampler must stand facing the direction of flow and approach the location from the downstream direction.
- e. Precautions must be taken not to disturb the bottom prior to scooping.
- f. The sample shall be scooped in the upstream direction of flow.

5.5.2.2 Corers

- a. Coring devices can be easily fabricated from many materials. Although stainless steel, glass or teflon must be used for sampling trace organics, other inexpensive material (PVC, carbon steel, etc.) may be used for demands, nutrients, metals as appropriate.
- b. Some corers are simple "push tubes", whereas other more sophisticated models may be finned, gravity driven devices.
- c. Not only are they useful in sampling fine grain sediments, they can also present or preserve the historical layering of sediments.
- d. Upon descent, water displacement is minimal, which also minimizes the shock wave produced by other equipment (dredges).
- e. The corer is the equipment of choice for fine sediments in static waters, especially trace organics and metals.
- f. Corer diameter, grain size, and sample consistency will determine if the sample will remain in the corer upon withdrawal.

- g. Sample washout can be a problem and there are several ways to reduce or prevent it.
 - 1. The leading edge of the corer can be fitted with a nosepiece or core catcher which physically keeps the sample from slipping back out the corer.
 - a) The core catcher material must also be compatible with analytes of interest.
 - 2. A second option is fitting the top or back end with a check valve which first creates negative pressure on the back of the sample as it is being pulled from the substrate and second, prevents surface water from washing out the top portion of the sample.
- h. The corer shall be rotated as it is pushed in.
 - 1. Rotation should be around its axis, not rocked back and forth.
 - 2. Rotation improves penetration and prevents compaction of the sample as it is pushed to the full length of the corer.
- i. Upon withdrawal from the water surface, a cap shall be placed on the bottom to prevent the sample from sliding out.
- j. The core should then be extruded out into a pan or tray and sample processed as described in Section 5.2 above.
- k. Corers can also be fitted with liners. This is advantageous if a complete core is desired that has not been in contact with the atmosphere. It is also advantageous if the coring device is not constructed of the proper material (e.g. PVC) and one of the analytes requires a sampler of inert construction (glass, SS, or Teflon).

5.5.2.3 Dredges

- a. The three main types are the Peterson, Eckman, and Ponar.
- b. The Peterson and Ponar dredges are suitable for hard or rocky substrates.

1. The Peterson and Ponar are virtually the same, except the Ponar has been adapted with a top screen and side plates to prevent sample loss upon ascent. For this reason, the Ponar is the dredge of choice for rocky substrates. These dredges are heavy enough to use in streams with fast currents.
- c. The Eckman is designed for softer substrates of sand, silt, or mud.
 1. The Eckman is too light to use in fast currents.
 - d. Follow the manufacturer's suggestions for setting and operating the weighted messenger devices.

5.6 Waste Pile Sampling

The Remedial Investigation Workplan provides the procedures for discrete and composite samples.

6.0 SAMPLE HANDLING

6.1 Sample Containers

6.1.1 Obtaining Clean Containers

Sample containers shall be cleaned or obtained by one of three protocols:

- a. Purchased from commercial vendors as precleaned containers. The cleaning grades must meet EPA analyte specific requirements. All records for these containers (lot numbers, certification statements, date of receipt, etc.) and their intended uses must be documented; or
- b. Obtained from a subcontracted laboratory with an approved sample cleaning and handling protocols in their Comprehensive QA Plan.
- c. Cleaned and maintained by the organization following all analyte specific container cleaning procedures as follows:

6.1.2 Container Cleaning Procedures

The numbered procedures are described after Table 6-1.

TABLE 6-1

Analysis/Parameter	Cleaning Protocols (in order specified)
Extractable Organics (GC, HPLC, GC/MS and Total Phenols)	1, 2, 4, 6, (5 and 7 optional), 12
Purgeable Organics (VOCs) (GC, GC/MS, TOX)	1, 2, 4, (6 optional, methanol only), 7

Metals (Including Cr and Hg)	1, 2, 3, 4, 8, 12
Inorganics (Including Cyanide, Alkalinity, Acidity, Residues, BOD, Color, Surfactants, COD, TOC, Chloride, Turbidity, Sulfate, Bromide, Sulfide, Fluoride, Nutrients and Radionuclides)	1, 2, 3*, 4, 8, 9, 12 (* For nutrients, nitric acid should be replaced by hydrochloric acid, or hydrochloric acid may be used after the nitric acid rinse)
Oil & Grease (and TRPH)	1, 2, 3, 4, (5, 6, 7 optional), 12
Bacteriologicals	1, 2, 8, 10
Toxicity Tests (Bioassays)	1, 2, 11, 2, 4, 6 (10 optional)

- NOTES: a) New container cleaning procedures may skip steps 1 and 2.
b) This sheet does not represent all possible cleaning procedures, and deviations may be accepted on a case by case basis.

Cleaning Procedures:

1. Wash with hot tap water and a brush using a suitable laboratory-grade detergent.
Organics- Liquinox, Alconox or equivalents
Inorganic anions- Liquinox or equivalent
Inorganic cations- Liquinox, Acationox, Micro or equivalents
Bacteriologicals- must pass an inhibitory residue test.
2. Rinse thoroughly with hot tap water.
3. Rinse with 1:1 nitric acid solution.

4. Rinse thoroughly with deionized water.
5. Rinse thoroughly with pesticide-grade methylene chloride.
6. Rinse thoroughly with pesticide grade acetone or methanol (acetone only for Bioassays).
7. Oven dry at 103 C to 125 C for at least 1 hour.*
 - * VOC vials and containers should remain in the oven in a contaminant-free environment until needed. They should be capped in a contaminant-free environment just prior to dispatch to the field or to field sampling consultants.
8. Invert and air-dry in contaminant-free environment.
9. Container is rinsed with sample unless container already contains preservative.
10. Autoclave containers (the tops of which are covered with aluminum foil and autoclave indicator tape is applied over the top of the container).
11. Rinse with 10% HCl followed by a sodium bicarbonate solution.
12. Cap tightly and store in a contaminant-free environment until use.

6.1.3 Documentation

- a. Records of packing slips and lot numbers (if ordered) and/or records of cleaning protocols for container lots must be maintained.
- b. Cleaning records shall at a minimum record the following:
 1. Cleaning procedure;
 2. Lot numbers of reagent solvents and acids;
 3. Date of cleaning;
 4. Initials of person who cleaned containers;
 5. Lot number (date of cleaning may be used);
 6. If performed, the results of quality control tests that were run on lot numbers; and
 7. Any additional cleaning or problems that were encountered with a specific lot.

- c. Records shall be maintained that link lot numbers (either vendor or internal) to projects and/or clients.

6.2 Sample Preservation and Holding Times

6.2.1 General Considerations

- a. Proper sample preservation is the responsibility of the sampling team, NOT the lab providing sample containers.
- b. It is the responsibility of the field team to assure that all samples are appropriately preserved.
- c. "IMMEDIATELY" is defined as within 15 minutes. This pertains to preservation as well as filtration immediately followed by preservation (i.e. dissolved metals, orthophosphate, etc.).

6.2.2 Sample Preservation

- a. Sample preservation shall be accomplished by obtaining prepreserved bottles from an acceptable source or actually adding preservative to the sample in the field:
 - 1. Sample containers obtained from the subcontracted laboratory prepreserved. The laboratory shall supply additional same-source preservatives in suitable containers.
 - 2. Sample containers preserved in the field after sample addition. These preservation protocols shall be followed:
 - a. Preservatives shall be reagent grade or of a higher grade. Unless supported by equipment blanks, the acid for metals shall be suitable for trace metals analysis
 - b. Fresh preservatives shall be obtained from parent stocks prior to each sampling event. Any remaining preservatives that are not in sealed ampoules SHALL NOT be returned to stock, but must be appropriately

- discarded.
- c. Preservatives shall be transported to the field in plastic or teflon containers unless sealed by the manufacturer in glass ampoules.
 - d. Preservatives shall be added with disposable pipettes or premeasured ampoules to each sample container
 - e. The same amount of preservative shall be added to the associated equipment blanks
- b. The pH shall be checked on all pH preserved samples (except VOC, O&G, and TRPH) using the following protocol:
- 1. The effectiveness of required pH adjustment must be checked in the field.
 - 2. Narrow range pH paper shall be used to test an ALIQUOT of the preserved sample.
 - a) Pour a small portion of the sample into disposable container
 - b) Place the pH paper into the container and compare the color with the manufacturer's color chart
 - c) Discard the aliquot appropriately. DO NOT POUR BACK INTO THE SAMPLE CONTAINER.
 - 3. If the pH is acceptable (ex. greater than 10, less than 2, etc.), document acceptability in field records and prepare container for shipment to the laboratory.
 - 4. If the pH is unacceptable:
 - a) Add additional preservative in measured increments, mix and test ALIQUOTS of the sample as described above.
 - b) Continue to add measured increments of preservatives until an acceptable pH has been reached.
 - c) Record the TOTAL amount of preservative that was needed.
 - d) Additional chemical preservatives used in the field shall be from the same source as the chemical used for original preservation. DO NOT

REUSE OLD SUPPLIES OF PRESERVATIVES.

5. Alternatively, an extra "dummy sample" may be used to test pH. Contents of the containers shall be suitably discarded.
6. The same amount of additional chemical preservative shall be added to the corresponding equipment blank (or field blank, if used). NOTE: the maximum amount of preservative that was used to preserve any single sample in the sample set SHALL BE ADDED to the equipment blank.
7. Sample pH shall be checked at the following minimum frequencies:
 - a) during the first sampling event at a particular site, ALL samples that are pH-adjusted must be checked, and
 - b) during subsequent visits to a particular site, AT LEAST ONE sample per parameter group that must be pH-adjusted shall will be checked.
 - c) If the frequency of sample collection at a specified location is greater than once per month (i.e. weekly or daily), the pH checks shall be made on AT LEAST ONE sample per parameter group according to the following schedule:
 - 1) Weekly sampling - 1 pH check per month
 - 2) Daily sampling - 1 pH check per week
 - 3) < 1 sampling episodes per day - a minimum of 1 pH check, and 1 additional check per 10 sampling episodes.
- c. The organization preparing and preserving the containers must keep all documentation for preservation, consisting of:
 1. the grades and lot numbers of all preservation reagents
 2. the opening date and expiration date.
 3. the specific preservation technique that was used with each sample.

6.2.3 Holding Times, Container Types and Preservation

Holding time, container type and required preservation for samples shall

comply with the following tables:

- a. Table A-2 (Table II of 40 CFR Part 136)

6.2.4 Special preservation protocols:

- a. All special preservation protocols outlined in Section 4.2 of the surface water section shall be followed for all aqueous samples.
- b. Samples for Chlorophyll shall be treated as follows:
 - 1. samples shall be filtered in the laboratory within 24 hr. of collection,
 - 2. magnesium carbonate shall be added to the filter while the last of the filtrate passes through the filter,
 - 3. the sample will be either analyzed immediately or frozen for later analysis within 21 days.

6.3 Sample Dispatch

6.3.1 Documentation

Field documentation will consist of, at a minimum, field notes, sample labels and Chain of Custody forms (or sample transmittal forms). These items must contain a minimum amount of information that can be traceable back to the original sampling event. A complete discussion of the mandatory information to be completed in the field are in the QAPP.

6.3.2 Sample Packing and Transport

- a. Samples shall be packed such that they are segregated by site, sampling location or by sample analysis type. Sample segregation may follow this segregation scheme or any other that is sensible and well thought out. These schemes are dependent upon the levels of contamination present, the number of bottles to be transported, the size of the bottles, etc.
 - 1. VOC samples from different locations may be placed into the same cooler

to reduce the number of required trip blanks provided that the samples are wrapped or containerized (ziplock bag or metal can) separately.

2. Samples in breakable containers shall be packed with materials (i.e. bubble wrap, cans with vermiculite) to avoid breakage.
 3. Shipping transport containers shall be insulated (if cooling is required).
 4. Shipping containers shall be sealed with strapping tape or locked to avoid tampering. Tamper-proof seals may also be placed over cooler lid.
 5. All samples that require thermal preservation shall be packed in thermally insulated coolers with wet ice. Only wet ice shall be used in cooling samples to 4°C. BLUE ICE OR CHEMICAL COOLING PACKS ARE NOT ACCEPTABLE.
- b. Packed samples shall be delivered to the analyzing laboratory by the sampling team or via common carrier.
1. If sent by common carrier, all documentation (transmittal form, bill of lading, analyses order, etc.) shall be sealed and placed inside the shipping container prior to sealing it closed.

6.4 Field Reagent Handling

All reagents, cleaning materials and preservatives that are maintained in the field shall be stored, transported and handled in such a way to prevent and/or minimize contamination.

The following storage and use protocols shall be observed:

- a. All chemicals that are maintained in-house and transported to the field shall be segregated according to reactivity (i.e. acids, bases, etc.).
- b. If possible, acids should be stored in an acid storage cabinet and solvents should be stored in a vented solvent storage cabinet. If specialized storage is unavailable, all chemicals shall be stored in a well-ventilated area.

- c. All chemicals transported to the field shall be stored in bottles which will be packed to avoid breakage.
- d. If quantities of reagent chemicals are transferred from the original container, the transport container shall be appropriately precleaned and must be of similar construction type as the original container (e.g. acids and bases may be transported in plastic or teflon containers).
- e. Chemicals shall be segregated from sample containers so as to avoid reaction and accidental contamination.
- f. Acids and bases must be segregated to prevent reaction.]]
- g. Analyte-free water shall be segregated from solvents to prevent contamination.

6.5 Field Waste Disposal

6.5.1 General Considerations

Field-generated wastes may require segregation and containerization for proper disposal by a commercial contractor. This decision is highly dependent upon which type of work is being conducted and the nature of the waste. In general, these wastes can be categorized as: (1) decontamination wastes, especially waste solvents, (2) waste acids and bases, (3) contaminated purge waters, and (4) calibration standards from field meters.

- a. All field investigations will generate some amount of waste material, especially groundwater investigations. Boring, developing, purging, and sampling monitor wells will generate soils, waters, and spent reagents that must be handled in a way that will not spread or increase contamination at the site. Activities from other sampling matrices will generate similar wastes.
- b. These wastes are normally categorized into hazardous and non-hazardous wastes.
 - 1. Hazardous wastes must be disposed of according to any and all applicable Federal (RCRA, CERCLA, etc.), State, County, or municipal regulations.

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2. Non-hazardous wastes must also be disposed of appropriately.
- c. Proper handling and disposal of all waste materials should be addressed prior to initiating site work. The following are a list of some materials that will require proper treatment, storage, and disposal. Additionally, these must be segregated by their hazardous or non-hazardous nature:
 1. personnel equipment: coveralls, gloves, boots, suits, disposable booties,
 2. disposable equipment: ground covers, equipment covers (aluminum foil, plastic garbage bags, etc.), disposable bailers or tubing, broken or unused sample containers, shipping containers, etc.,
 3. soil cuttings from drilling or hand boring,
 4. drilling mud or fluid,
 5. development and purge waters,
 6. decontamination wastes: spent solvents and acids, and
 7. spent calibration standards for field analytical equipment (field GC, conductance, pH, etc.).

6.5.2 Decontamination Wastes

- a. Decontamination and calibration wastes must be segregated and disposed of properly.
- b. Soap solutions and waste tap/DI/analyte-free water can be disposed of on site.
- c. Calibration standards (pH and conductance) may be diluted with spent detergent solution and wash waters and disposed of in sanitary sewer.
- d. Weak acid solutions may be neutralized or diluted and disposed of properly.
- e. Waste solvents shall be handled as hazardous waste and must be collected and transported back to the office or lab to be handled by commercial disposal or recycling contractor. DISCHARGE OR EVAPORATION OF WASTE SOLVENTS ON-SITE, IN ANY AMOUNT, IS NOT ACCEPTABLE. See discussion below on hazardous waste handling.

- f. Concentrated, reagent grade preservative acids and bases shall be transported back to the office, laboratory, or disposed of by commercial contractor.
- g. Field GC standards must be handled as a waste solvents.

6.5.3 Disposal of purged water

- a. Contaminated purge waters must be handled prudently.
- b. If wastewater generated from well development or purging of monitor wells is likely to contain contaminants in excess of the MCL (maximum contaminant level), the water shall be contained on-site in temporary storage (e.g., lined pit, drum, tank or tanker truck) until the waters can be characterized by the appropriate approved analytical method(s).
- c. In many cases it may be possible to directly discharge contaminated purged water on-site, but only if the purged water will infiltrate into the SAME aquifer zone from which it was purged from or into a more contaminated aquifer zone.
- d. Additionally, exposure of such purged water must not pose a health risk and the purged water shall not be discharged into any surface water body, unless permitted.
- e. Purged water must be adequately treated (contaminants should not exceed established standards) prior to discharge on-site if the above conditions cannot be met.
- f. Alternatively, purged water may be transported to an off-site facility such as sewage treatment plant/sewer system (some wastewater treatment systems are capable of treating water with total VOC concentrations up to 500 ppm). THE WASTEWATER TREATMENT PLANT OPERATOR MUST BE NOTIFIED AND MUST GIVE APPROVAL BEFORE DISCHARGE CAN OCCUR.

6.5.4 Field Generated Hazardous Waste

Handling, storage and disposal of field-related hazardous wastes are subject to the regulations contained in the Resource Conservation and Recovery Act.

All of the procedures listed in this subsection pertain to the company, field consultant, primary contractor, etc. whomever is performing and is responsible for the field sampling event. For brevity, we will refer to this organization as the field consultant.

a. Responsibilities

1. The field consultant is responsible for all wastes generated on-site as a result of the sampling event, excluding those waste materials already present on-site (contaminated drill cuttings, purge water, etc.).
2. It is the responsibility of the field consultant to store, package, label, ship and dispose of the hazardous wastes which are generated during the sampling event or project in a manner which ensures compliance with all Federal, State and local laws, regulations and ordinances.
3. Responsibility may also be assumed by the property owner. These requirements will not specify who is ultimately responsible. This decision will be made by the property owner and the primary contractor with regard to ALL of the RCRA requirements.
4. The field consultant is responsible for the waste if it contaminates the environment; therefore, precautions should be taken to secure all reagents (acids, bases, solvents, etc.) that, if spilled, would be characterized as a hazardous waste (listed in 40 CFR Part 261.30-.33 or if a characteristic waste).

b. Definitions

1. A hazardous waste can be defined by any one of the following criteria;
 - a) The waste material is listed in 40 CFR Part 261.30-261.33.

- b) The material exhibits any of the specified characteristics: ignitability; corrosivity; reactivity or TC toxicity.

2. Classification

- a) Field consultants that generate hazardous waste are put into 3 categories based on the amount of hazardous waste generated monthly. These categories are; 1) conditionally exempt small quantity generator, 2) small quantity generator and 3) full generator.

- b) Conditionally Exempt Small Quantity Generator: A generator who generates no more than 100 kilograms of hazardous waste in a calendar month. (40 CFR Part 261.5)

- c) Small Quantity Generator:

A generator who generates more than 100 kilograms but no more than 1000 kilograms of hazardous waste per calendar month or generates less than 1 kilogram of acute hazardous waste and accumulates no greater than 6000 kilograms of hazardous waste. (40 CFR Part 262.34)

- d) Full Generator:

A generator who generates wastes in excess of 1000 kilograms per calendar month or more than 1 kilogram per month of acute hazardous waste. (40 CFR Part 262.34).

- 3. It is the responsibility of the field consultant to know which category their organization falls under. Since most field consultants will fall into the conditionally exempt small quantity generator category, these requirements are listed below.

c. Hazardous waste Handling Protocols for Conditionally Exempt Small Quantity Generators

- 1. These generators may either treat or dispose of hazardous waste in an on-site facility or ensure delivery to an off-site treatment, storage or disposal facility, either of which, if located in the U.S., is:

- a) Permitted under Part 270 of the federal regulations
- b) In interim status under Parts 270 & 265.
- c) Authorized to manage hazardous waste by a state with a hazardous waste management program approved under Part 271.
- d) Permitted, licensed, or registered by a state to manage municipal or industrial solid waste. *(subject to local regulations).
- d. Hazardous Waste Handling Protocols for Facilities falling into the Small Quantity Generator and Full Generator
 - 1. These organizations must adhere to all regulations pertaining to waste disposal in the Resource Conservation and Recovery Act.
- e. General Disposal/Treatment Considerations:
 - 1. Hazardous waste solvents, as identified in the 40 CFR Part 261, shall not be evaporated on-site by pouring onto pervious or impervious surfaces.
 - a) These solvents shall also not be evaporated at the office or lab with or without a fume hood.
 - b) Solvents that evaporate during the actual decontamination process are exempt.
 - 2. Acidic and Basic wastes may be neutralized and disposed of via the sanitary sewer if they are not hazardous due to the presence of other constituents*. (*subject to local regulations).
- f. Transportation
 - 1. There are no special handling requirements for transportation of these wastes back to the office or laboratory.
 - 2. There are no requirements for manifesting the waste nor placarding the vehicle (if for small quantities).
 - 3. A sample collector shipping samples to a laboratory and a laboratory returning samples to a sample collector must comply with U.S. Department of Transportation (DOT), U.S. Postal Service (USPS), or any other

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applicable shipping requirements.

g. Storage and Accumulation:

1. Hazardous waste storage is limited by quantity and/or accumulation time and must comply with RCRA regulations as specified in the 40 CFR.
2. These wastes shall be packaged and separated according to compatible groups (e.g. solvents, acids, etc.).

h. Sample Disposal:

1. Samples submitted to a laboratory for analysis are excluded from regulation as hazardous waste under 40 CFR Part 261.4(d) provided the samples are being transported to or from the laboratory, or are being analyzed, are being held for analysis, or are being maintained in custody for legal reasons.
2. Once a decision is made to dispose of laboratory samples, the exclusion provisions of 40 CFR Part 261.4(d) no longer apply.
3. Samples that have been identified as hazardous may either be: 1) returned safely to the generator; or 2) disposed of according to applicable RCRA regulations summarized in this document.
4. Samples which are determined to be non-hazardous may be subject to local environmental regulations. It will be the responsibility of the laboratory to be familiar with any such local regulations.

7.0 CALIBRATION PROCEDURES AND FREQUENCY

7.1 INTRODUCTION

This SOP stipulates minimum calibration requirements necessary to ensure that the measuring system is capable of producing acceptable data. Acceptable calibration protocol must involve a demonstration that the instrument or measuring system is capable of acceptable performance at the beginning of the analysis sequence and that initial calibration is still valid after continued system operation.

7.2 GENERAL CONSIDERATIONS

- a. Calibrations must be performed according to all analytical method directives OR as indicated in this document if specifics are not addressed in the cited method.
- b. Analytical method calibration acceptance criteria must be followed or if acceptance criteria are not specified in the method, general criteria presented in this SOP shall be used to verify an acceptable calibration.
- c. Calibration of field instruments shall be performed on a regular basis with records kept on a separate calibration log. The records must indicate the method used to calibrate, the time and date, number of standard(s), resulting meter response, actions taken, and the results of the calibration. The meter: name, model number, and identification number (if applicable) shall be entered.
- d. Maintenance and repair notes shall be made in the maintenance logbook for each meter. If rental equipment is used, a log is not required. However, the origin (i.e. rental company), rental date, equipment type, model number and identification number (if applicable) shall be entered into the field notes or a rental equipment notebook.
- e. Prior to mobilization, the manager of the field crew must verify that all equipment is in proper working condition, calibrated, and that batteries are properly charged.
- f. Field calibration of each meter shall occur daily (if a sampling event occurs over several days), at the first sample site and must be verified throughout the day (as noted

in 7.5 below). This will ensure field data of a known quality. All field calibrations and checks shall be noted on field sheets.

7.3 STANDARD RECEIPT AND TRACEABILITY

- a. Records to be retained for primary stock standards must include source, type of standard, date of receipt, lot number (if applicable), expiration date and purity statement.
- b. Records to be maintained for preparation of intermediate standards must include identification of primary standards used, preparation date, methods of preparation (including specific dilution information), preparer identification, concentration prepared and expiration date.
- c. Preparation records for working standards must include identification of primary and intermediate standards used in working standard preparation, date of preparation, method of preparation (including dilutions), concentrations prepared and preparer identification.

7.4 FREQUENCY OF STANDARD PREPARATION AND STANDARD STORAGE

7.4.1 Standard Storage

- a. Standards must be stored according to analytical method guidance or supplier recommendations.
- b. If no method or supplier guidance is available standards must be replaced upon decreased instrument response.

7.4.2 Frequency of Standard Preparation

- a. If no method or supplier guidance is available standards must be renewed upon decreased instrument response.
- b. It is recommended that all primary standards be held for no longer than one year.

7.4.3 Documentation on calibration standards (e.g., buffers, KCl, and other reagents)

- a. At a minimum, the date of receipt, expiration dates (noted on the bottle label), and date of first use shall be noted on the standard container.
- b. Expiration dates must be followed.
- c. If reagents or standards are prepared from stock chemicals, they must be analytical reagent grade or better. Potassium chloride standards must be of primary standard grade.

7.5 MINIMUM QUALITY CONTROL REQUIREMENTS

- a. Once the meter has been calibrated, these checks shall take place at intervals of every 2 wells or 4 hours, whichever comes first, and at the end of the sampling day. For instance: the pH meter will be checked against the pH 7 buffer, thermistors will be checked against field-grade thermometers, conductance meters will be checked against one KCl standard, etc.
- b. If a field meter fails a continuing calibration, a complete initial calibration must be performed. In this way, meter response will be addressed without the need for generating historical precision and accuracy statistics.

7.6 PH METERS

7.6.1 General Concerns

- a. The pH meter is field calibrated on a daily basis (If a sampling event occurs over several days) at the first site. Since field meters do bump around from site to site, calibration is likely to change.
- b. Calibration may be checked on a weekly basis in the laboratory to ensure the % theoretical slope is not less than 90%, indicating a bad electrode. This should be noted in the calibration records. If % slope cannot be determined on the meter, or the manufacturer's optimum specifications are different, manufacturers

recommendation for maintaining optimum meter performance shall be followed.

- c. There are several interferences to keep in mind with pH measurement:
 - 1. sodium at pH $>$ or $=$ 10 can be reduced or eliminated by using a low sodium error electrode;
 - 2. coatings of oils, greases, and particulates may impair the electrode's response. The electrode bulb should be patted dry with lint-free paper or cloth and rinsed with deionized water. If not, acetone may be used to clean very hard to remove films, but must be used sparingly so the electrode surface is not damaged;
 - 3. temperature effects on the electrometric measurement of pH are controlled by using instruments having temperature compensation or by calibrating the meter at the temperature of the samples;
 - 4. poorly buffered solutions with low specific conductance (< 200 umhos/cm) may cause fluctuations in the pH readings. Equilibrate electrode by immersing in several aliquots of sample before taking pH.
- d. Follow the instructions with each type of pH meter. Use secondary standard buffer solutions (pH of 4, 7, 10) purchased from commercial vendors for calibration. Do not reuse buffers.
- e. Each meter/electrode system must be calibrated at a minimum of two points, at least three pH units apart, bracketing the expected sample pH. Check historical data for expected pH or use pH paper on an aliquot to estimate.
- f. Under normal conditions a pH measurement should be accurate to ± 0.1 pH unit.

7.6.2 Calibration and Field Use

- a. Check the battery before mobilizing and turn on the meter when you reach the first facility and allow it to equilibrate to ambient temperature.
- b. Calibrate the meters prior to taking samples:

1. Estimate the sample pH range (e.g., history, operator, litmus)
 2. Turn function switch to pH position
 3. Select the appropriate buffers to bracket the expected sample pH, either pH 4 buffer and pH 7 or pH 7 and pH 10.
 4. Remove the protective cap, rinse the electrode with deionized water (DI) and dab dry with lint-free paper or cloth.
 5. Place and swirl the electrode in the pH 7 buffer and turn the calibration knob until the reading is 7.0. Repeat step 4 above.
 6. Place and swirl the electrode in the second buffer solution (pH 4 or 10). Adjust the temperature knob until the reading is that of the pH standard. Repeat step 4 above.
 7. Measure the temperature of the second buffer solution.
 8. Turn the slope indicator until the arrow of the temperature compensator points to the temperature of the buffer. The percent to the theoretical slope should be read from the slope scale. A slope of less than 90% (or one not meeting the manufacturer's specifications) indicates a faulty electrode or contaminated buffer and the problem should be corrected before proceeding.
- c. After calibration follow these procedures to take a pH reading of a freshly collected sample:
1. Pour enough fresh sample into a pH measuring cup to take a reading and measure its temperature. If it differs more than 2 C from the buffer temperature, adjust for the difference by turning the slope indicator until the arrow to the temperature compensator points to the sample's temperature.
 2. Place and swirl the pH electrode in the sample (in the cup) and read the pH value. In the case of low specific conductance and meter drift, add 1 ml of 1M KCl (potassium chloride) solution to each 100 ml of sample, swirl and read pH. Note: to make 1M KCl solution, take 74.55 grams of primary standard grade KCl and add it to a 1 liter volumetric flask. Add DI to the 1 liter line

on the flask and mix. Solutions of the appropriate strength may be purchased from commercial laboratory suppliers.

3. Turn the meter off after the last reading, discard the sample in the cup, rinse the electrode thoroughly with deionized water and replace the electrode's rubber cap.
- d. In lieu of performing duplicate measurements (precision) or independent check standards (accuracy), additional calibration checks will be required. Continuing calibration must be done per the following:
 1. After the initial calibration, the pH meter shall be checked against the pH 7 buffer at intervals of every 2 wells or 4 hours, whichever comes first.
 2. The meter will also be checked against the 7 buffer after sampling has been completed.
 3. If the sampling event takes less than 4 hours, then an initial calibration and a post-calibration check will be adequate.
 4. If, during the continuing calibration, the response is greater than .2 pH units on either side of 7, then a complete initial calibration must be conducted.
 5. All initial and continuing calibrations shall be completely documented in bound notebook or field sheets, including: date/time, standard(s) used, resultant meter response, action taken, and technician initials.

7.7 TEMPERATURE

7.7.1 General Concerns

- a. Temperature determinations can be made with any field-grade mercury-filled, alcohol-filled, or dial-type Celsius thermometer as well as an electronic thermistor.
- b. All thermometric devices shall, at a minimum, be checked annually in the laboratory against a National Institute of Standards and Technology (NIST) precision thermometer.

1. The temperature measuring device should be checked at two temperatures against the NIST precision thermometer.
2. Temperatures should agree within $\pm 0.1^{\circ}\text{C}$. Make note of the calibration in the calibration records. Note the make, model, and serial number of each thermometer.
 - a) Thermometers that do not meet the acceptance criteria should be disposed of properly.
 - b) If the difference is shown to be constant (i.e. $+ 0.5^{\circ}\text{C}$) over the thermometer range, the thermometer may be used provided that the difference is documented for 10 degree increments, and the correcting factor is used in all measurements.
- c. Use care and proper cleaning procedures to prevent sample cross-contamination.

7.7.2 Calibration and Field Use

- a. All field-grade thermometers must have completed the annual check against the NIST-grade thermometer. All thermistors must be calibrated in the field with a field-grade (or NIST-grade) thermometer.
- b. Allow the thermometer or thermistor (always use one which has been properly calibrated) to equilibrate to ambient temperature.
- c. Insert thermometer or thermistor in situ when possible or in a portion of the sample. Swirl and take readings when the mercury column, needle, or read-out becomes constant; record the temperature to the nearest 0.5°C . Read to the nearest 0.1°C for a digital gage.
- d. Continuing calibration must also be performed for thermistors. The thermistor should be checked against the field-grade thermometer at 4 hour intervals and at the end of the sampling day.

7.8 DISSOLVED OXYGEN METER

7.8.1 General Concerns

- a. Before sampling the DO meter should be calibrated in water saturated air to make sure it is operating correctly. The DO meter should be calibrated on samples free of interference, in the laboratory, and against the Azide modification of the Winkler Method of determining dissolved oxygen on an annual basis.
- b. Turbulence is necessary to keep a constant flow of water across the membrane-sample interface. Be sure the stirrer is working before using the probe.
- c. Store the probe with a cover that creates a saturated atmosphere. A cap, with a wet sponge in it, will suffice.
- d. Before mobilizing, check to make sure there are no bubbles beneath the probe membrane and no wrinkles or tears in the probe membrane. If so, replace the membrane and KCl. Check the leads, contacts, etc. for corrosion and/or shorts if meter pointer remains off-scale, does not calibrate, or drifts.
- e. Dissolved inorganic salts are an interference with the performance of DO probes. For example, the taking of DO readings in salt water is affected by the salinity and must be corrected by adjusting the salinity knob. Adjust the meter based on readings taken from the specific conductivity/salinity meter or use appropriate calculations to correct for salinity.
- f. Reactive gases which pass through the membrane may interfere. For example, chlorine will depolarize the cathode and cause a high probe output. Long term exposures to chlorine will coat the anode with the chloride of the anode metal and eventually desensitize the probe. Sulfide (from H₂S) will undergo oxidation if high enough potential (voltage) is applied, creating current flow, yielding faulty readings. If such interferences are suspected, the membrane electrode should be changed frequently, and must be calibrated at more frequent intervals.
- g. DO probes are temperature sensitive, and a method of temperature compensation is normally provided by the manufacturer.

7.8.2 Calibration and Field Use:

7.8.2.1 Annual Laboratory Calibration

- a. Fill a clean bucket with uncontaminated or deionized water and place the probe into the bucket. Siphon water from the bucket into two Biological Oxygen Demand (BOD) bottles. Make sure to place siphon hose on the bottom of the bottles and overflow the bottles by three volumes. Determine the DO by the Winkler method.
- b. Adjust the DO meter according to manufacturer's instructions. Be sure to adjust the meter to the temperature of water in the bucket, then calibrate the DO indicator dial to read the average DO concentration of the two samples determined by the Winkler test.
- c. Keep a calibration log.
- d. If the air calibration seems to operate properly but the oxygen concentrations disagree with the results of the Winkler calibration by more than 0.2 mg/L it is time to have the electrode or meter serviced or replaced.

7.8.2.2 Field Calibration

Prior to mobilizing and at each sample site, air calibrate the DO meter in water saturated atmosphere to make sure the meter is reading correctly.

- a. Turn meter on for at least 10 minutes before the initial field calibration and use. With lint-free paper or cloth, wipe any droplets off the membrane surface. For YSI meters, and most others, the meter must remain on redline to keep the membrane polarized. Do not turn off until the end of the day.
- b. Once the probe/calibration chamber are stable at ambient temperature, check the air temperature and determine, from the DO versus temperature table (usually on the meter's battery pack), what the DO should measure. (You can't get a stable ambient temperature if the probe is sitting in the sun).
- c. With the probe as close to the water surface as possible (saturated atmosphere)

turn the knob to read DO. Adjust the calibration knob until the DO reading is at the theoretical level determined in b. above.

7.8.2.3 Field Use

- a. Using the salinity measurement (if appropriate) from the conductivity meter, adjust the salinity control knob on the DO meter (ignore if your meter automatically adjusts for salinity). Take the DO reading and record it on the field sheet.
- b. Place the DO probe at the depth and location appropriate to what you are measuring. For example, take the DO of an effluent just before it enters a receiving water. If the effluent has cascading or other aeration prior to entering the surface water, take the DO reading in the receiving water right where it enters. For well mixed surface waters, e.g., fast flowing streams, take the DO reading at approximately 1-2 feet below the surface or at mid-depth. For still or sluggish surface waters, take a reading at one foot below the surface, one foot above the bottom, and at mid-depth. If it is shallow, say less than two feet, take the reading at mid-depth. Do not take a reading in frothy/aerated water since you may get a false reading.
- c. Keep the probe in the saturated atmosphere (see 7.8.1c. above) between sites and events. If the readings show distinct, unexplainable changes in DO levels, or when the probe has been in waters with high sulfides, recalibrate using the Winkler method.
- d. While taking a reading, if it is very low, e.g., below 1.0 ppm, allow it to stabilize, record it and then, remove and rinse the probe, as the environment is very likely anoxic and may contain hydrogen sulfide, which can damage the probe.
- e. Continuing calibration must also be performed on the DO meter. The meter should be air calibrated at 4 hour intervals and at the end of the sampling day.

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7.9 SPECIFIC CONDUCTIVITY METER

Specific conductance is a useful method to approximate the total amount of inorganic dissolved solids. Conventional conductivity devices consist of two or more platinum electrodes separated by a test solution. The major disadvantage with this type of system is the possibility of polarization or poisoning (fouling) of the electrodes. Conductivity systems based on the measurement of inductance or capacitance are also available. The electrodes in these systems are insulated by a layer of glass or other insulating material. System response is less rapid, but problems with fouling and polarization are eliminated. Conductivity varies with temperature. For example, the conductivity of salt water increases 3%/degree C at 0°C, and only 2 %/degree C increase at 25° C. Therefore, it is necessary to record temperature with conductivity measurements or to adjust the temperature of the samples prior to making conductivity measurements. Most conductivity meters have temperature compensation.

7.9.1 General Concerns

- a. Follow the manufacturer's instructions.
- b. Samples are preferably analyzed at 25°C. If not, temperature corrections are made and results reported at 25° C.
- c. With good equipment an accuracy of +/- 1% of the reading is achievable.
- d. Typically a conductivity meter is combined with a thermistor to measure water temperature. The temperature measurements are used for both conductivity and DO corrections.

7.9.2 Calibration and Field Use

7.9.2.1 Laboratory Calibration

- a. The meter should be checked in a laboratory in one of three ways:
 1. Follow method specifications;
 2. Use two standard potassium chloride solutions of 100 and 1,000 umhos/cm

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- or standards that bracket the range of expected sample conductance; or
3. A single check standard in each range of a multi-range instrument.
 - b. If the meter does not read within 1% of the standards, determine what the problem is and correct it before proceeding. Most field instruments read conductivity directly. If the meter does not correct all values to 25° C, calculate corrective factors using the procedure in 7.9.3 below. Record all readings and calculations in the calibration records.

7.9.2.2 Field Calibration

The meter must be calibrated in the field with at least one KCl standard prior to analyzing the first sample. The chosen standard must be close to the conductance value of the real samples.

7.9.2.3 Field Use

- a. Typically, the conductivity probe is immersed at the same time, depth, and location as the DO probe. Measure the water temperature with the conductivity probe.
- b. If the meter is equipped with automatic temperature compensation, adjust the temperature knob on the conductivity meter to the water temperature and read the conductivity. The conductivity meter has a set of positions which multiply the reading by powers of ten in order to measure the full range of potential conductivities. You will need to set this dial to the correct range in order to take a reading. The reading, with the temperature gauge adjusted properly, reports conductivity measured at 25° C.
- c. Switch the dial to take a salinity reading. Use this reading to adjust the DO meter for salinity, if necessary. This should not be used for reporting salinity as a measured parameter, since the calibration is not directly applicable. It may be used as an estimate for salinity for compensation of a DO

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measurement.

- d. Continuing calibration must be performed on the conductance meter. The meter should be checked against the one KCl calibration standard at 4 hour intervals and at the end of the sampling day.
- e. Rinse off the probe with deionized water and turn off when finished for the day.

7.9.3 Calculations

- a. If the meter does not automatically correct for temperature, or if a probe with a cell constant other than 1 is used, the following formula shall be used to correct the data to 25° C:

$$K = \frac{K_m(C)}{1 + 0.0191(T-25)}$$

Where: K = conductivity in umhos/cm at 25° C

K_m = measured conductivity in umhos/cm at T degrees C

C = cell constant

T = measured temperature of the sample in degrees C

If the cell constant is 1, the formula for determining conductivity becomes:

$$K = \frac{(K_m)}{1 + 0.0191(T-25)}$$

- b. Refer to SM 2510B, 17th edition, if other calculations (i.e. determining cell constant, etc.) are required.

7.10 TURBIDITY

7.10.1 General Concerns

- a. Sample cells must be extremely clean and free from significant scratches. Minor imperfections in the glass are effectively masked by applying silicone oil.
- b. Touching the sample cells with bare hands should be avoided. The cells should be lifted by the cap when at all possible.
- c. Before mobilizing, the batteries should be checked. A set of batteries should always be transported to the field. Recalibration is required after replacing the batteries.

7.10.2 Calibration and Field Use:

7.10.2.1 Quarterly laboratory Calibration

- a. The turbidimeter will be calibrated with formazin standards of 20, 100, and 800 NTU every three months. Standards must be made IMMEDIATELY before use.
- b. Formazin standard solutions will be prepared from a 4000 NTU stock solution. The prepared stock solution is stable for up to one year when properly prepared.
- c. Dilution water will be prepared per the manufacturers directions.
- d. The 20, 100 and 800 NTU standards will be prepared per the manufacturers directions.
- e. Follow the manufacturers directions to calibrate the instrument.
- f. Document the formazin standards used, date of calibration, person performing calibration and any problems which might have occurred in the calibration log.

7.10.2.2 Field Calibration

Gelex cells shall be used for field calibration. The standards for these Gelex cells must be adjusted as the instrument is adjusted due to calibration from the

formazin standards performed in the laboratory. Three Gelex samples shall be transported to the field and used for field calibration. The range of these three standards are 0-10 NTU, 0-100 NTU, 0-1000 NTU. The reading of the Gelex standards from the turbidimeter after calibration will be written on the cap of the Gelex cell. Readings from the Gelex standards should be obtained prior to taking the first sample, every 2 wells or 4 hours, whichever comes first, and at the end of the sampling day. If the reading is not within 5% of the previously established value, the instrument should be recalibrated with the formazin primary standard.

7.10.2.3 Field Use

- a. Fill a clean sample cell to the fill line.
- b. After placing the cap on the cell, wipe the cell with a soft, lint-free cloth to remove water spots.
- c. Apply a silicon oil down the length of the cell and wipe with a soft cloth to obtain an even film over the entire surface.
- d. Put the sample cell in the instrument so the diamond or orientation mark aligns with the orientation mark on the instrument.
- e. Close the lid.
- f. Press the button(s) to obtain the reading. Do not hold the instrument while taking a reading.

7.11 ORGANIC VAPOR METERS

Organic vapor meters may be used to perform qualitative or screening procedures in many different situations. These devices are equipped with either a flame ionization (FID) or a photoionization (PID) detector. The FID ionizes organic molecules via a hydrogen flame, whereas the PID uses a lamp. Lamps with different electron voltage (eV) may be used with the PID to ionize specific groups or classes of organic compounds. For specific lamp applications consult the owners manual.

These meters may be used for ambient air screening at sites for health and/or safety reasons. They can be used for headspace analyses of soil samples to determine "gross contamination", for well placement, or for grid sampling. Calibration and use of these types of meters should be performed after consulting the owners manual. There are several procedures that must be accomplished at a minimum:

- a. Calibration must be performed on-site, prior to sampling, it is also suggested that additional calibrations against one span gas be performed at 4 hour intervals and/or at the end of the sampling day.
- b. The meter must be zeroed with "zero air" or equivalent. If known to be free from interfering components, ambient air may be used.
- c. At least one span gas must be used for calibration.
- d. Carbon filters must be used to distinguish between methane and other aliphatic halocarbons (FIDs only).
- e. Background corrections must be made if soil borings or split spoon samples are analyzed in ambient air (unnecessary for headspace samples performed in mason jars under foil).

7.12 AUTOMATIC WASTEWATER SAMPLERS

These pieces of equipment are invaluable for remote sampling or for sophisticated time- or flow-dependent sampling regimes. Since loading calculations of industrial and domestic wastewater are dependent upon the sampling accuracy, these devices must be volume calibrated by checking the constant pumping volume at least twice with a graduated cylinder or other calibrated container.

7.13 CALIBRATION DOCUMENTATION

Records must be maintained to document and verify acceptable instrument or measuring system calibration for each analysis.

- a. Records must be maintained for all standard preparations and working standards must be easily traced to intermediate and primary standards used for preparation.
- b. Acceptable calibration verification (% recoveries, correlation coefficients) must be recorded and easily identified with applicable calibrations.
- c. If calibration acceptance criteria are based on manufacturer's instrument specifications or acceptable recoveries specified by QC check sample suppliers, then records of such activities must be maintained. Such records must be easily accessible and must establish verification of acceptance criteria.

7.14 DEFINITIONS

7.14.1 Mid-Range Standard

A standard in the middle of the linear range of the established calibration curve or a standard concentration in the middle of the expected sample concentration range depending on the type of determination to be performed.

7.14.2 Intermediate Standard

A standard prepared from the primary stock standard which is diluted to prepare the working calibration standards.

7.14.3 Working Standards

The standards that are actually analyzed to perform the instrument or measuring system calibration.

8.0 GROUNDWATER WELL INSTALLATION

8.1 Groundwater Well Construction

Following is a description of the specifications and procedures proposed for construction of the groundwater monitoring wells.

8.1.1 Drilling Methods

A variety of well drilling methods are available for the purpose of installing groundwater monitoring wells. The drilling method shall minimize the disturbance of subsurface materials and shall not cause contamination of the groundwater. Regardless of the drilling method selected, drilling equipment shall be steam cleaned before use and between borehole locations to prevent cross contamination of wells. This site will employ hollow-stem continuous auger drilling or air rotary method. Other methods will be used should conditions require it.

8.1.2. Monitoring Well Construction Materials

Well construction materials shall be sufficiently durable to resist chemical and physical degradation and yet not interfere with the quality of groundwater samples. Materials to be used for well casings, well screens, filter packs, and annular seals are covered below.

a. Well Casings and Screens

ASTM, NSR rated, Schedule 40, 2 inch PVC shall be used for the casing pipe and well screens at this site. It should be understood that since PVC pipe is being selected for casing and screening material there may be the possibility that after installation PVC deteriorating compounds could be present in the groundwater. If these compounds are detected, then it must assume that the contaminants are contained in the groundwater sample and not from the well casing or screen unless identical compounds are found in the upgradient wells

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and can not be attributed to wastes on-site.

Plastic pipe sections must be flush threaded or be amenable to connection by another mechanical method such as stainless steel screws. No solvents or glues should be allowed in well construction. These compounds readily leach organic contaminants into the ground water. All well casings and screens should be steam cleaned prior to emplacement to ensure that all oils, greases and waxes have been removed.

b. Filter Pack and Annular Sealant

The materials used to construct the filter pack shall be chemically inert clean quartz sand. Fabric filters shall not be used as filter pack materials. Natural gravel packs are acceptable provided an appropriate well screen slot size is used.

The materials used to seal the annular space must prevent cross contamination between strata. The materials shall be chemically resistant to ensure seal integrity during the life of the monitoring well and chemically inert so they do not affect the quality of the groundwater samples. A minimum of two feet of certified coarse grit sodium bentonite shall immediately overlie the filter pack. A cement and bentonite mixture, bentonite chips/pellets, or anti-shrink cement mixtures shall be used as the annular sealant in the unsaturated zone above the certified coarse grit sodium bentonite seal and below the frost line. Extending from a little below the frost line to the surface, the cap shall be composed of concrete blending into a mounded cement apron (to direct rainwater runoff away from the well) extending outward three feet from the edge of the borehole.

The untreated sodium bentonite seal shall be placed around the casing either by dropping it directly down the borehole or, if a hollow-stem auger is used, putting the bentonite between the casing and the inside of the auger stem. Both of these methods present a potential for bridging. In shallow monitoring wells,

a tamping device shall be used to reduce this potential. In deeper wells, it may be necessary to pour a small amount of formation water down the casing to wash the bentonite down the hole.

The cement-bentonite mixture shall be prepared using formation water or potable water and placed in the borehole using a tremmie pipe. The tremmie method ensures good sealing of the borehole from the bottom.

The remaining annular space shall be sealed with expanding cement to provide for security and an adequate surface seal. Locating the interface between the cement and bentonite-cement mixture 1/2 to 1 foot below the frost line, serves to protect the well from damage due to frost heaving. The cement shall be placed in the borehole using the tremmie method.

A one-quarter inch vent hole provides an avenue for the escape of gas. The protective cap guards the casing from damage and the locking cap serves as a security device to prevent well tampering.

As with drilling machinery, the well casing and screen shall be steam cleaned before use. Filter sands, well sealant materials, and anything else that may influence sample quality shall be free of contamination.

8.1.3 Well Intake Design

The design and construction of the intake of the monitoring wells shall:

1. allow sufficient groundwater flow to the well for sampling;
2. minimize the passage of formation materials (turbidity) into the well; and
3. ensure sufficient structural integrity to prevent the collapse of the intake structure.

For wells completed in unconsolidated materials, the intake of a monitoring well shall consist of a screen or slotted casing with openings sized to ensure that formation material is prohibited from passing through the well during development. Screen size shall be selected to retain 90% of the filter pack and

40% of the formation material. Extraneous fine-grained material (clays and silts) that have been dislodged during drilling may be left on the screen, in the filter pack, and in the well water. These fines shall be removed from the screen and surrounding area during development. For quality-control purposes, only commercially manufactured screens or slotted casings shall be used. Field slotting of screens is unacceptable.

Screening with 0.010 inch slots shall be used unless geologic conditions discovered at the time of installation dictate a different size. The annular space between the face of the formation and the screen or slotted casing shall be filled to minimize passage of formation materials into the well. A filter pack of clean, well rounded, quartz sand or glass beads in each monitoring well that is constructed on site is recommended. In order to ensure discrete sample horizons, the filter pack shall extend no more than two feet above the well screen. A different filter pack material may have to be considered should geologic conditions at the time of drilling dictate the need for a different size.

8.1.4 Well Development

After the construction of monitoring wells is completed, natural hydraulic conductivity of the formation shall be restored and all foreign sediment removed to ensure turbidity-free groundwater samples. A variety of techniques are available for developing a well. To be effective, they require reversals or surges in flow to avoid bridging by particles, which is common when flow is continuous in one direction. These reversals or surges can be created by using surge blocks, bailers, or pumps. Formation water shall be used for surging the well. Should a well be constructed in low yielding water-bearing formations, an outside source of water may be introduced into the well to facilitate development. In these cases, the water shall be chemically analyzed to ensure that it cannot contaminate the aquifer. If compressed air is used in the

development of wells there is the possibility that trace contaminants may be introduced. Therefore, sufficient precaution shall be taken to prevent introduction of contaminants which may be cause for concern. All equipment used to develop a well shall be steam cleaned prior to its introduction into the well.

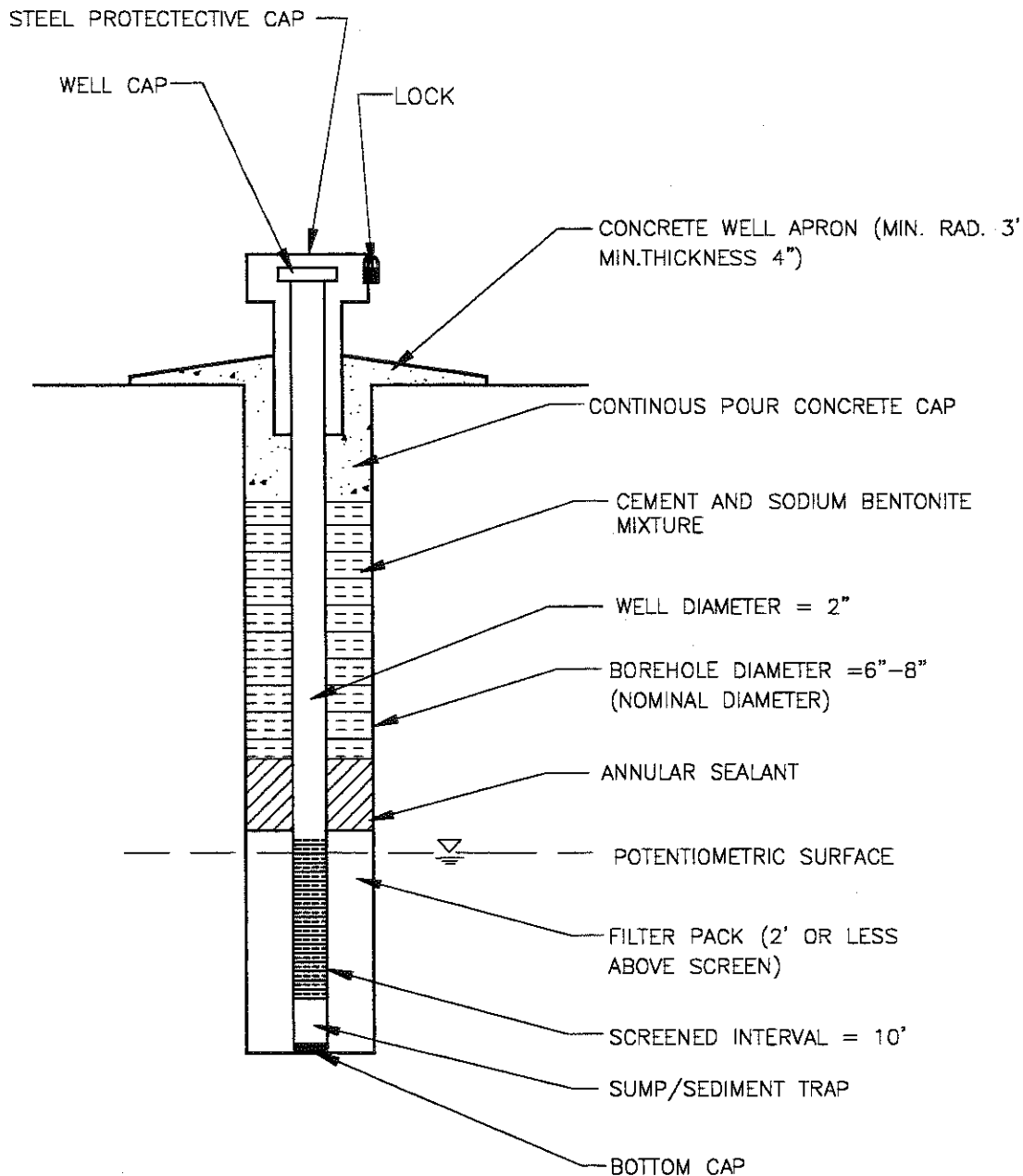
8.1.5 Documentation of Well Design and Construction

The following information shall be required in the design and construction of wells:

- name of driller, identification of drill rig;
- date of construction;
- drilling method and drilling fluid * (primarily drilling mud) used;
- well location (± 0.5 ft.);
- borehole diameter and well casing diameter;
- well depth (± 0.1 ft.);
- drilling and lithologic logs;
- casing materials;
- screen materials and design;
- casing and screen joint type;
- screen slot size/length;
- filter pack material/size;
- filter pack volume;
- filter pack placement method;
- sealant materials;
- sealant volume;
- sealant placement method;
- surface seal design/construction;
- well development procedure;

- type of protective well cap;
- ground surface elevation ($\pm .01$ ft.);
- well cap elevation ($\pm .01$ ft.);
- top of casing elevation (± 0.1 ft.); and
- detailed drawing of well (include dimensions).

FIGURE 8-1



PROPOSED GROUNDWATER WELL CONSTRUCTION

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9.0 GROUNDWATER WELL ABANDONMENT

9.1 Procedure

If it becomes necessary to abandon a monitoring well, the following procedures shall be used. Without proper methods, the abandoned monitoring well may become an avenue of aquifer contamination. Plugging the well can serve to inhibit water loss from artisan aquifers and to eliminate the physical hazard of an open hole. The general procedure for removing and plugging shallow monitoring wells completed in water table aquifers are outlined as follows:

- a. The protective cover and concrete plug shall be removed.
- b. A 3-1/4 inch or larger inside diameter hollow core auger shall be placed over the 2 inch diameter well casing and advanced to the bottom of the original borehole.
- c. The well casing and screen shall be removed from the auger if possible; if not, the auger shall be removed with the well casing and screen lodged within its core.
- d. If not removed at this point, the auger shall be removed from the borehole.
- e. A tremmie pipe shall be lowered to the bottom of the borehole; if excessive caving has occurred, the tremmie pipe shall be removed, the hollow core auger shall be returned to the borehole, and the tremmie pipe shall be lowered to the bottom of the auger's hollow core.
- f. Cement/bentonite grout shall be pumped through the tremmie pipe to the bottom of the borehole. As the borehole is filled with grout, the tremmie pipe (and auger, if in the borehole) shall be gradually removed. The tremmie pipe shall remain below the grout surface at all times, thus ensuring grout continuity and an effective seal.
- g. The upper 1 foot of the borehole shall be plugged with concrete to form an effective and durable cap.
- h. The materials removed from the borehole, unless otherwise directed, shall be considered to be non-hazardous.

9.2 Sealant Materials

Well sealants shall be chemically inert and impermeable. Neat portland cement (with or without bentonite clay additives) and bentonite clay are acceptable sealants. General purpose (Type I) neat portland cement is acceptable. The cement slurry is to be mixed with five to six gallons of water for each 94 pound sack of cement. The water of the cement slurry should have a low sulfate content and a total dissolved solids content less than 2,000 parts per million. No aggregate materials are to be included in the slurry.

Bentonite clay additives reduce shrinking (and cracking) of the cement while the slurry is setting. Three to five pounds of additive and 6-1/2 gallons of water shall be mixed with each 94 pound sack of cement (the clay and water are to be mixed together before cement is added to form the slurry). Bentonite clay cannot be used as a sealant where organic contaminants are present in groundwater unless the bentonite is treated and documentation is presented to show that it is capable of containing organic contaminants.

APPENDIX A

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TABLE A-1

EQUIPMENT	CONSTRUCTION HOUSING ²	TUBING	USE	PERMISSIBLE PARAMETER GROUPS	RESTRICTIONS AND PRECAUTIONS ¹
WATER SAMPLING <u>Groundwater</u>					
1 Positive Displacement Pumps					
a. Submersible ³ (turbine, helical rotor, gear driven	SS, Teflon	SS, Teflon	Purging Sampling	All parameter groups All parameter groups (excluding VOCs)	a,b; in-line check valve required a,b; in-line check valve required
	SS, Teflon	Non-inert ⁴	Purging Sampling	All parameter groups Demands, Nutrients, Metals, Radiochemistry	a,b; in-line check valve required; polishing required ⁵ none tubing non-metallic if not SS

1 Restrictions/precautions listed on the last page of this chart.

2 This category refers to tubing and pump housings/internal parts that are in contact with purged or sampled water.

3 Submersible pumps may be used for purging or sampling only if no other pumping device is available, since lines (power cords, gas pressure tubing) may not be (practically) constructed of inert materials.

4 "Non-inert" pertains to materials which are reactive (adsorb, absorb, etc.) to the analytes being sampled. Materials include: polyethylene, PVC, and other plastics if organics are of interest and metallic equipment (brass, galvanized, and carbon steel, etc.) if trace metals are of interest.

5 "polishing": When purging for organics, the entire length of tubing or portion of which comes in contact with the formation water should be constructed of teflon or stainless steel. If other materials (i.e., PVC< HDPE, or polypropylene) are used, the following protocols must be followed: 1) contact with formation waters is minimized by slowly withdrawing the pump from the water column during the last phase of purging, thus removing from the well any water which may have contacted the exterior of the pump and/or tubing; 2) a single well volume must be removed with the sampling device before sampling begins. Tygon™ must never be used for purging when organics are of interest. NOTE: THE USE OF NON-INERT (i.e. PVC, HDPE, ETC.) IS NOT RECOMMENDED.

TABLE A-1 (Continued)

<u>EQUIPMENT</u>	<u>CONSTRUCTION</u> <u>HOUSING²</u>	<u>TUBING</u>	<u>USE</u>	<u>PERMISSIBLE PARAMETER GROUPS</u>	<u>RESTRICTIONS AND PRECAUTIONS¹</u>
b. Bladder Pump (no gas contact)	Non-inert	Non-inert ⁴	Purging	All parameter groups	a,b; in-line check valve required; polishing required
			Sampling	Demands, Nutrients, Metals, Radiochemistry	none tubing non-metallic if not SS
	SS, Teflon	SS, Teflon	Purging	All parameter groups	a,b
			Sampling	All parameter groups	a,b; bladder must be Teflon is sampling for organics
2. Suction Lift Pumps a. Centrifugal	SS, Teflon	Non-Inert ³	Purging	All parameter groups	a,b; polishing required; this configuration <u>not</u> recommended
			Sampling	Demands, Nutrients Metals, Radiochemistry	none tubing non-metallic if not SS
	Non-inert ³	Non-inert ³	Purging	All parameter groups	a,b; polishing required
			Sampling	Demands, Nutrients Metals, Radiochemistry	None housing & tubing non-metallic if not SS
	N/A	SS, Teflon	Purging	All parameter groups	b; foot-valve required
			Purging	All parameter groups	b; foot-valve required; polishing required

¹ Restrictions/precautions listed on the last page of this chart.

² This category refers to tubing and pump housings/internal parts that are in contact with purged or sampled water.

³ "Non-inert" pertains to materials which are reactive (adsorb, absorb, etc.) to the analytes being sampled. Materials include: polyethylene, PVC, and other plastics if organics are of interest and metallic equipment (brass, galvanized, and carbon steel, etc.) if trace metals are of interest.

TABLE A-1 (Continued)

<u>EQUIPMENT</u>	<u>CONSTRUCTION</u> <u>HOUSING²</u>	<u>TUBING</u>	<u>USE</u>	<u>PERMISSIBLE PARAMETER GROUPS</u>	<u>RESTRICTIONS AND PRECAUTIONS¹</u>
WATER SAMPLING					
<u>Groundwater</u> Pumps, cont.					
b. Peristaltic	N/A	SS/Teflon	Purging Sampling	All parameter groups Demands, Nutrients Metals, Radiochemistry	b; foot-valve or continuous pumping required none b; medical grade silicone tubing in pump head
c. Pitcher, Hand (above ground)	N/A	SS/Teflon	Purging	All parameter groups	b; must use foot-valve
d. Pitcher, Hand (submersible) (e.g., B-K pump)	Non-inert ³	Non-inert ³ N/A	Purging Purging	All parameter groups All parameter groups	b; must use foot-valve; polishing required a; polishing required
3 Bailers	SS, Teflon		Purging Sampling	All parameter groups All parameter groups	none; not recommended none
	Non-inert ³		Purging Sampling	Demands, Nutrients Metals, Radiochemistry Demands, Nutrients Metals, Radiochemistry	none; not recommended must be nonmetallic if not SS none must be nonmetallic if not SS

¹ Restrictions/precautions listed on the last page of this chart.

² This category refers to tubing and pump housings/internal parts that are in contact with purged or sampled water.

TABLE A-1 (Continued)

<u>EQUIPMENT</u>	<u>CONSTRUCTION</u> <u>HOUSING²</u>	<u>TUBING</u>	<u>USE</u>	<u>PERMISSIBLE PARAMETER GROUPS</u>	<u>RESTRICTIONS AND PRECAUTIONS¹</u>
<u>WATER SAMPLING</u>					
<u>Surface Water</u>					
1 Nansen, Kemmerer, Vandom (or equivalent)	SS, Teflon or Teflon-Coated		Specific Depth Grab Sampling	All parameter groups	none
2 DO Dunker	SS, Teflon or Glass		Water Column Composite Sampling	All parameter groups	none
3 Bailers	SS, Teflon Non-Inert ³		Grab Sampling Grab Sampling	All parameter groups Demand, Nutrients Metals, Radiochemistry	none none must be nonmetallic if not SS
Field Filtration Units	N/A		Dissolved constituents	Demand, Nutrients Metals in groundwater and static wastewater and surface water	must use a 0.45 µm filter No intermediate vessels; positive pressure HDPE & Teflon bailers acceptable
			Dissolved constituents	Metals in moving surface water (ie, river/stream)	must use positive pressure device, but an intermediate vessel may be used

¹ Restrictions/precautions listed on the last page of this chart.

² This category refers to tubing and pump housings/internal parts that are in contact with purged or sampled water.

³ "Non-Inert" pertains to materials which are reactive (adsorb, absorb, etc.) to the analytes being sampled. Materials include: polyethylene, PVC, and other plastics if organics are of interest and metallic equipment (brass, galvanized, and carbon steel, etc.) if trace metals are of interest.

TABLE A-1 (Continued)

<u>EQUIPMENT</u>	<u>CONSTRUCTION</u> <u>HOUSING²</u>	<u>TUBING</u>	<u>USE</u>	<u>PERMISSIBLE PARAMETER GROUPS</u>	<u>RESTRICTIONS AND PRECAUTIONS¹</u>
<u>SOLID SAMPLING</u> <u>Sediments/Soils</u>					
1 Core Barrel (or liner)	SS, Teflon, Glass, Teflon-coated, Aluminum		Sampling	All parameter groups	c,d,e
	Non-inert ³		Sampling	Demands, Nutrients Metals, Radiochemistry	none d
2 Trowel, Scoop, Spoon or Spatula	SS, Teflon or Teflon- coated		Sampling	All parameter groups	
			Compositing	All parameter groups except VOCs	VOC samples may not be taken from composite samples
3 Mixing Tray (pan)	SS, Teflon, Glass, Teflon Coated or Aluminum		Sampling and Compositing	Demands, Nutrients Metals, Radiochemistry	none must be nonmetallic if not SS
			Sampling	All parameters groups	e
			Compositing or homogenizing	All parameter groups except VOCs	e

¹ Restrictions/precautions listed on the last page of this chart.

² This category refers to tubing and pump housings/internal parts that are in contact with purged or sampled water.

TABLE A-1 (Continued)

<u>EQUIPMENT</u>	<u>CONSTRUCTION</u> <u>HOUSING</u>	<u>TUBING</u>	<u>USE</u>	<u>PERMISSIBLE PARAMETER GROUPS</u>	<u>RESTRICTIONS AND PRECAUTIONS</u>
SOIL SAMPLING Mixing Tray, Cont.					
	Non-inert ¹			Compositing or homogenizing Demands, Nutrients Metals, Radiochemistry	none e; must be nonmetallic if not SS
4 Shovel, Hand auger, Bucket Auger	SS		Sampling	All parameter groups	none
	Non-SS		Sampling	Demands, Nutrients	none
5 Split spoon	SS or carbon steel w/ teflon insert		Sampling	All parameter groups	c,d
6 Shelby tube	SS		Sampling	All parameter groups	c
	Carbon steel		Sampling	All parameter groups	c,d; samples for VOC and Metals must be taken from the interior of the core sample

Key to Restrictions/Precautions

- if used as a non-dedicated system, pump must be completely disassembled, if practical, and cleaned between wells.
- Delivery tubing must be precleaned and precut at the base of operations or laboratory. If the same tubing is used during the sampling event, it must be cleaned and decontaminated between use.
- if samples are sealed in the liner for transport to the laboratory, the sample for VOC analysis must be taken from the interior part of the core.

¹ "Non-inert" pertains to materials which are reactive (adsorb, absorb, etc.) to the analytes being sampled. Materials include: polyethylene, PVC, and other plastics if organics are of interest and metallic equipment (brass, galvanized, and carbon steel, etc.) if trace metals are of interest.

- d. Liners must be constructed of stainless steel or a suitable non-metallic material. If a metallic (carbon steel, aluminum) liner is used with the core barrel, the samples for metals shall be taken from the interior part of the core sample.
- e. Aluminum foil, trays or liners may be used only if aluminum is not an analyte of interest.

Acronyms:

N/A	not applicable
SS	stainless steel
HDPE	high density polyethylene
PVC	polyvinyl chloride
VOC	volatile organic compound

TABLE A-2

40 CFR Part 136 TABLE II: REQUIRED CONTAINERS, PRESERVATION TECHNIQUES,
AND HOLDING TIMES
(WATER/WASTEWATER SAMPLES)

PARAMETER #	PARAMETER NAME	CONTAINER ¹	PRESERVATION ^{2,3}	MAX HOLD TIME ⁴
Table 1A-Bacterial Tests:				
1-4.	Coliform, fecal and total	P, G	Cool 4C, 0.008% Na ₂ S ₂ O ₃ ⁵	6 hours
5.	Fecal streptococci	P, G	Cool 4C, 0.008% Na ₂ S ₂ O ₃ ⁵	6 hours
Table 1B-Inorganic Tests:				
1.	Acidity	P, G	Cool 4C	14 days
2.	Alkalinity	P, G	Cool 4C	14 days
4.	Ammonia	P, G	Cool 4C, H ₂ SO ₄ to pH<2	28 days
9.	Biochemical oxygen demand	P, G	Cool 4C	48 hours
11.	Bromide	P, G	None required	28 days
14.	Biochemical oxygen demand carbonaceous	P, G	Cool 4C	48 hours
15.	Chemical oxygen demand	P, G	Cool 4C, H ₂ SO ₄ to pH<2	28 days
16.	Chloride	P, G	None required	28 days
17.	Chlorine, total residual	P, G	None required	Analyze immediately
21.	Color	P, G	Cool 4C	48 hours
23-24.	Cyanide, total and amenable to chlorination	P, G	Cool 4C, NaOH to pH>12, 0.6g ascorbic acid ⁵	14 days ⁶
25.	Fluoride	P	None required	28 days
27.	Hardness	P, G	HNO ₃ to pH<2, H ₂ SO ₄ to pH<2	6 months
28.	Hydrogen ion (pH)	P, G	None required	Analyze immediately
31, 43.	Kjeldahl and organic nitrogen	P, G	Cool 4C, H ₂ SO ₄ to pH<2	28 days

TABLE A-2 (Continued)

PARAMETER #	PARAMETER NAME	CONTAINER ¹	PRESERVATION ^{2,3}	MAX HOLD TIME ⁴
Metals⁷				
18.	Chromium VI	P, G	Cool 4C	24 hours
35.	Mercury	P, G	HNO ₃ to pH<2	28 days
3. 5-8, 10, 12, 13, 19, 20, 22, 26, 29, 30, 32- 34, 36, 37, 45, 47, 51, 52 58- 60, 62, 63, 70- 72, 74, 75	Metals, except chromium VI and mercury	P, G	HNO ₃ to pH<2	6 months
38.	Nitrate	P, G	Cool 4C	48 hours
39.	Nitrate-nitrite	P, G	Cool 4C, H ₂ SO ₄ to Ph<2	28 days
40.	Nitrite	P, G	Cool 4C	48 hours
41.	Oil and grease	G	Cool 4C, H ₂ SO ₄ to pH<2	28 days
42.	Organic carbon	P, G	Cool 4C, HCl or H ₂ SO ₄ to pH<2	28 days
44.	Orthophosphate	P, G	Filter immediately, Cool 4C	48 hours
Table 1C-Organic Tests:⁸				
13, 18-20, 22, 24-28, 34-37, 39-43, 45-47, 56, 66, 88, 89, 92-95, 97.	Purgeable Halocarbons	G, Teflon-lined septum	Cool 4C, 0.008% Na ₂ S ₂ O ₃ ⁵	14 days
6, 57, 90	Purgeable aromatic hydrocarbons	"	Cool 4C, 0.008% Na ₂ S ₂ O ₃ ⁵ HCl to pH2 ⁹	14 days
3, 4,	Acrolein and acrylonitrile	"	Cool 4C, 0.008% Na ₂ S ₂ O ₃ ⁵ Adjust pH to 4-5 ¹⁰	14 days
23, 30, 44, 49, 53, 67, 70, 71, 83, 85, 96.	Phenols ¹¹	G, Teflon lined cap	Cool 4C, 0.008% Na ₂ S ₂ O ₃ ⁵	7 days until extraction, 40 days after extraction
7, 38.	Benzidines ^{11,12}	"	Cool 4C, 0.008% Na ₂ S ₂ O ₃ ⁵	7 days until extraction, 40 days after extraction ¹³
14, 17, 48, 50- 52.	Phthalate esters ¹¹	"	Cool 4C	7 days until extraction, 40 days after extraction
72-74.	Nitrosamines ^{11,14}	"	Cool 4C, store in dark, 0.008% Na ₂ S ₂ O ₃ ⁵	"

TABLE A-2 (Continued)

PARAMETER #	PARAMETER NAME	CONTAINER ¹	PRESERVATION ^{2,3}	MAX HOLD TIME ⁴
76-82.	PCBs ¹¹ acrylonitrile	"	Cool 4C	"
54, 55, 65, 69.	Nitroaromatics and isophorone ¹¹	"	Cool 4C, 0.008% Na ₂ S ₂ O ₃ ⁵ store in dark	"
1, 2, 5, 8-12, 32, 33, 58, 59, 64, 68, 84, 86.	Polynuclear aromatic hydrocarbons ¹¹	"	"	"
Table 1D-Pesticides Tests:				
1-70.	Pesticides ¹¹	"	Cool 4C, pH 5-9 ¹⁵	"
Table 1E-Radiological Tests:				
1-5.	Alpha, beta and radium	P, G	HNO ₃ TO pH<2	6 months

Reference: This table is reprinted from 40 CFR Chapter I, Revised as of July 1, 1988. According to Federal Register of Thursday, September 3, 1987, preservation for Oil and Grease may also be performed with HCl

¹. Polyethylene (P) or Glass (G).

². Sample preservation should be performed immediately upon sample collection. For composite chemical samples each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then chemical samples may be preserved by maintaining at 4° C until compositing and sample splitting is completed.

³. When any sample is to be shipped by common carrier or sent through the United States Mails, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172). The person offering such material for transportation is responsible for ensuring such compliance. For the preservation requirements of Table II, the Office of Hazardous Materials, Materials Transportation Bureau, Department of Transportation has determined that the Hazardous Materials Regulations do not apply to the following materials: Hydrochloric acid (HCl) in water solutions at concentrations of 0.04% by weight or less (pH about 1.96 or greater); Nitric acid (HNO₃) in water solutions at concentrations 0.15% by weight or less (pH about 1.62 or greater); Sulfuric acid (H₂SO₄) in water solutions at concentrations of 0.35% by weight or less (pH about 1.15 or greater); and Sodium hydroxide (NaOH) in solutions at concentrations of 0.080% by weight or less (pH about 12.30 or less).

⁴. Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid. Samples may be held for longer periods only if the permittee, or monitoring laboratory, has data on file to show that the specific types of samples under study are stable for the longer time, and has received a variance from the Regional Administrator under Part 136.3(e). Some samples may not be stable for the maximum time period given in the table. A permittee, or monitoring laboratory, is obligated to hold the sample for shorter time if knowledge exists to show that this is necessary to maintain sample stability. See Part 136.3(e) for details.

⁵. Should only be used in the presence of residual chlorine.

⁶. Maximum time is 24 hours when sulfide is present. Optionally all samples may be tested with lead acetate paper before pH adjustments in order to determine if sulfide is present. If sulfide is present, it can be removed by the addition of cadmium nitrate powder until a negative spot test is obtained. The sample is filtered and then NaOH is added to pH 12.

- ⁷ Samples should be filtered immediately on-site before adding preservative for dissolved metals.
- ⁸ Guidance applies to samples to be analyzed by GC, LC, or GC/MS for specific compounds.
- ⁹ Sample receiving no pH adjustment must be analyzed within seven days of sampling.
- ¹⁰ The pH adjustment is not required if acrolein will not be measured. Samples for acrolein receiving no pH adjustment must be analyzed within 3 days of sampling.
- ¹¹ When the extractable analytes of concern fall within a single chemical category, the specified preservative and maximum holding times should be observed for optimum safeguard of sample integrity. When the analytes of concern fall within two or more chemical categories, the sample may be preserved by cooling to 4 C, reducing residual chlorine with 0.008% sodium thiosulfate, storing in the dark, and adjusting the pH to 6-9; samples preserved in this manner may be held for seven days before extraction and for forty days after extraction. Exceptions to this optional preservation and holding time procedure are noted in footnote 5 (re the requirement for thiosulfate reduction of residual chlorine), and footnotes 12, 13 (re the analysis of benzidine).
- ¹² If 1,2-dephenyl hydrazine is likely to be present, adjust the pH of the sample to 4.0 "0.2 to prevent rearrangement to benzidine.
- ¹³ Extracts may be stored up to 7 days before analysis if storage is conducted under an inert (oxidant-free) atmosphere.
- ¹⁴ For the analysis of diphenylnitrosamine, add 0.008% Na₂S₂O₃ and adjust pH to 7-10 with NaOH within 24 hours of sampling.
- ¹⁵ The pH adjustment may be performed upon receipt at the laboratory and may be omitted if the samples are extracted within 72 hours of collection. For the analysis of aldrin, add 0.008% Na₂S₂O₃.

TABLE A-3

**RECOMMENDED SAMPLE CONTAINERS, SAMPLE VOLUMES, PRESERVATION TECHNIQUES
AND HOLDING TIMES FOR RESIDUALS, SOIL AND SEDIMENT SAMPLES ¹**

PARAMETER GROUP	METHODS	REFERENCES	CONTAINER	PRESERVATION	MAX HOLDING TIMES
Volatile Organics	Purge-and-Trap GC and GC-MS	8010, 8015, 8020, 8021, 8230, 8240, 8260	Glass, 40 ml vial or 4 oz. wide- mouth with Teflon/silicone septum ²	³	14 days
Semivolatile Organics	GC, HPLC, and GC-MS	8040, 8060, 8080, 8090, 8100, 8120, 8250, 8270, 8310	Glass, 8 oz. widemouth with Teflon lined cap(50 grams sample)	³	14 days until extraction, 40 days after extraction.
Total Metals-except mercury and chromium VI	Flame AA, Furnace AA, Hydride and ICP	All 7000-series methods(except 7195, 7196, 7197, 7198, 7470, and 7471) and 6010 (ICP)	Glass or plastic, 8 oz. widemouth (200 grams sample)	³	6 months
Chromium VI	Colorimetric, Chelation with Flame AA	7196 and 7197	Glass or plastic, 8 oz. widemouth (200 grams sample)	³	24 hours
Mercury	Manual Cold Vapor AA	7471	Glass or plastic, 8 oz. widemouth (200 grams sample)	³	28 Days

¹. Adapted from tables 3-1 and 4-1 in Test Methods for Evaluating Solid Waste, SW-846, EPA, Third Edition, 1986, and First Update in 1987. The term residuals includes: (i) concentrated waste samples and (ii) sludges of domestic or industrial origin.

². Sample shall not be homogenized (mixed) prior to filling container. Container must be filled by packing as much sample into it leaving minimal headspace. Field samples can not be composited for analysis.

³. Soils, sediments and sludges shall be kept cool at 4° C from collection time until analysis. No preservation is required for concentrated waste samples.

